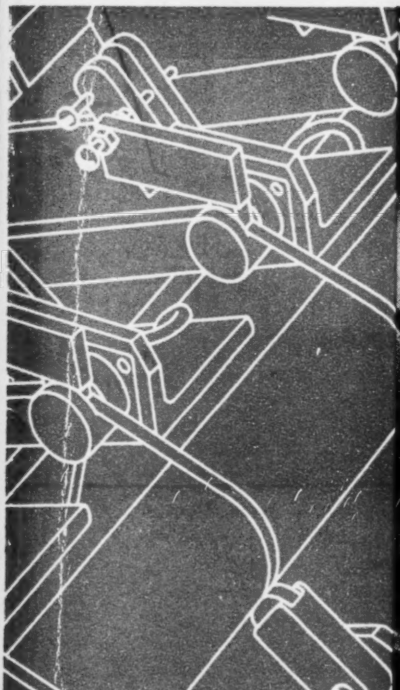
June 49

MACHINE DESIGN

June 1949



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- ELECTRIC CLUTCHES
- SMALL MOTORS
- PLASTER-MOLD CASTINGS
- MOLDED LAMINATES
- SPINDLE STRESSES

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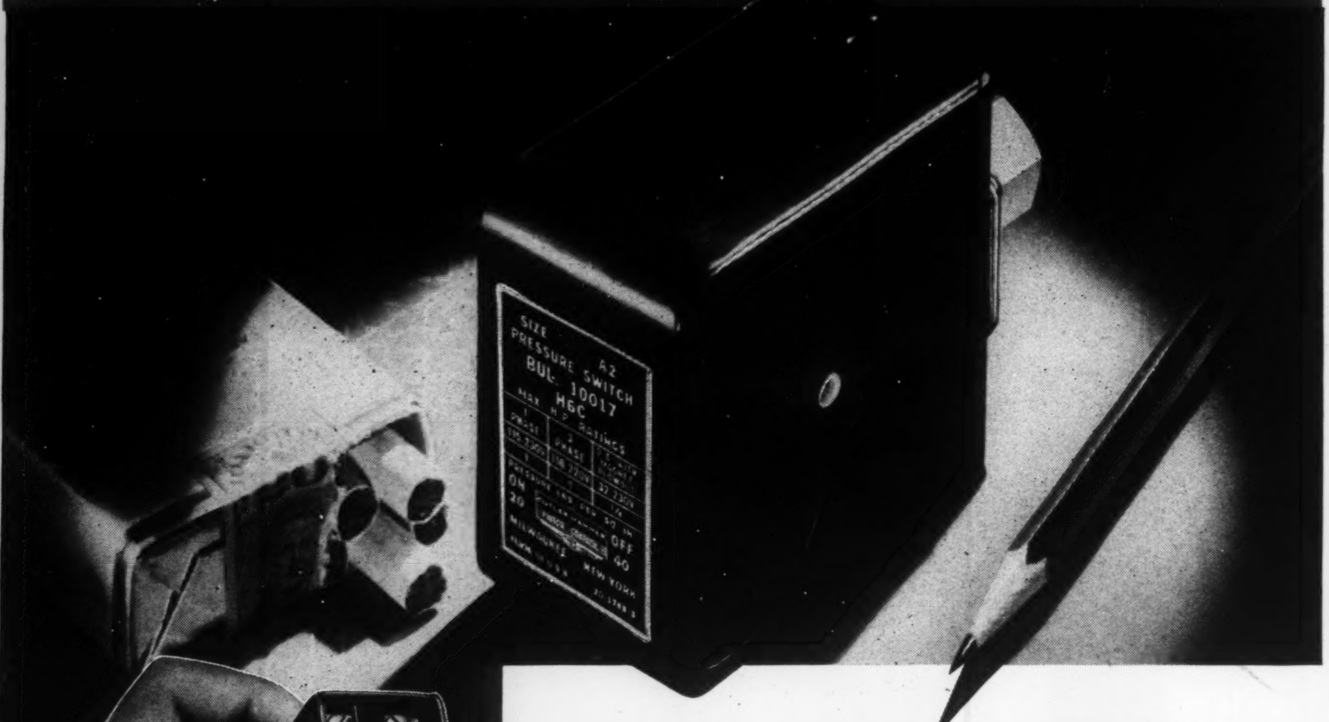
NEW SMALL PRESSURE SWITCH
for domestic water systems



Cutler-Hammer announces a new small pressure switch (Bulletin 10017) for motor driven domestic water systems. It is easy to design into your product, easy to mount into your assembly. One size fits all needs in the small pump field as well as small compressors, oil pumps, etc., and a wide selection of pressure fittings and mounting adaptors is available.

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Many other outstanding features are found in the 10017 pressure switch. It is another example of the unusual engineering so long identified with *and by* the Cutler-Hammer trademark. Send for further details. CUTLER-HAMMER, Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin.

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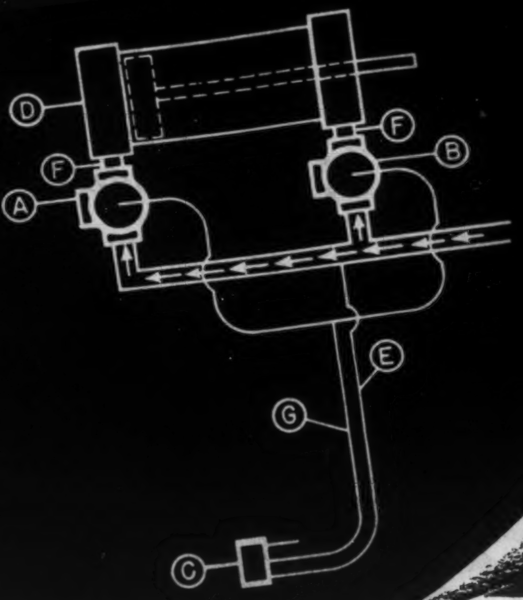

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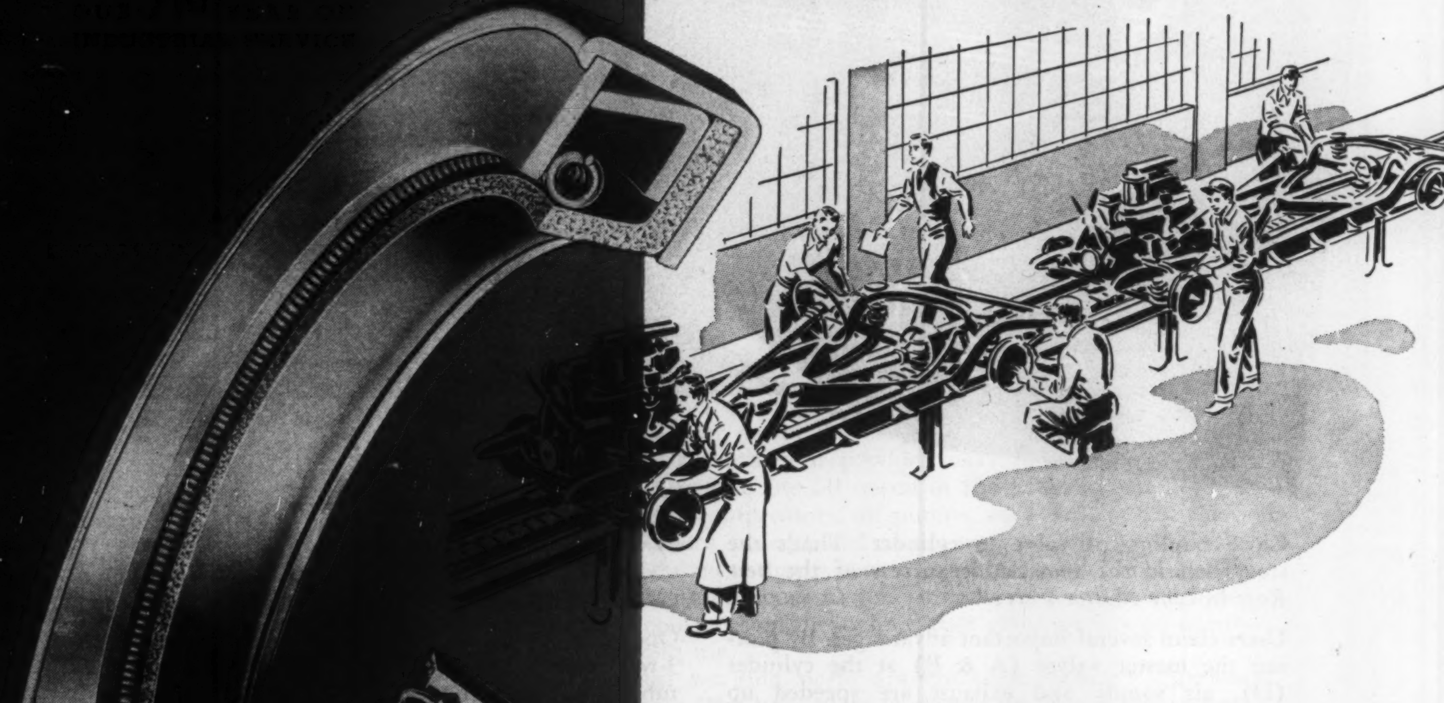

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MACHINE DESIGN

Vol. 21—No. 6 **June, 1949**

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

This Month's Cover: Multiple recorder, designed by Minnesota Mining & Manufacturing Co., picks up signals from a master magnetic tape and feeds them electrically into a number of re-record heads driven by a common capstan.

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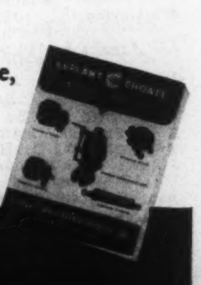

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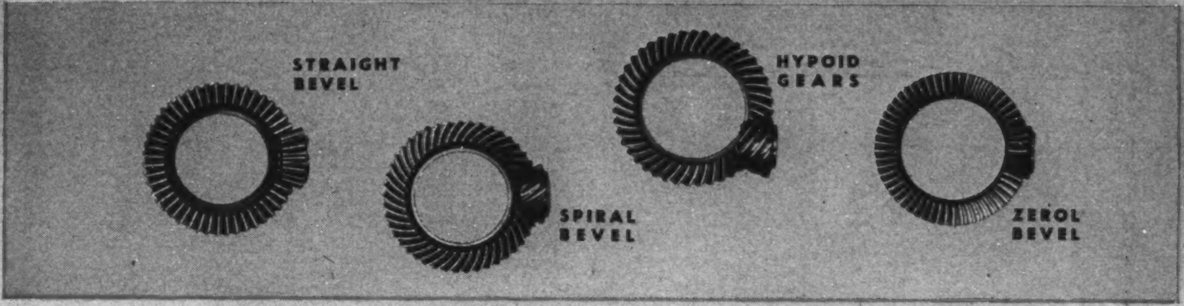

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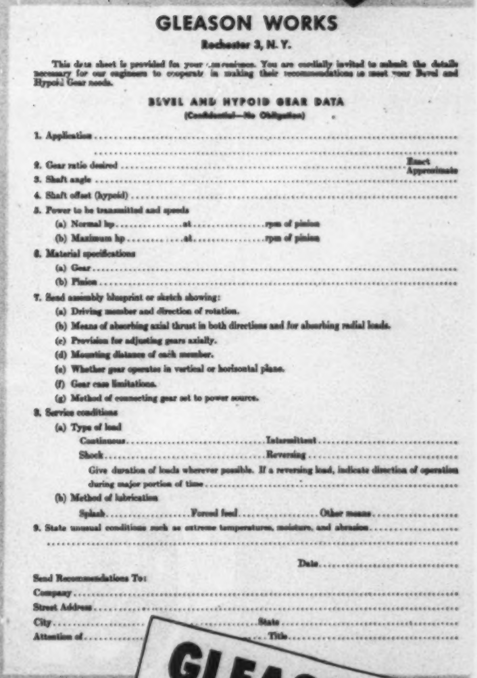

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1. Application ....
....
2. Gear ratio desired .... Exact / Approximate
3. Shaft angle ....
4. Shaft offset (hypoid) ....
5. Power to be transmitted and speeds
   (a) Normal hp .... at .... rpm of pinion
   (b) Maximum hp .... at .... rpm of pinion
6. Material specifications
   (a) Gear ....
   (b) Pinion ....
7. Send assembly blueprint or sketch showing:
   (a) Driving member and direction of rotation.
   (b) Means of absorbing axial thrust in both directions and for absorbing radial loads.
   (c) Provision for adjusting gears axially.
   (d) Mounting distance of each member.
   (e) Whether gear operates in vertical or horizontal plane.
   (f) Gear case limitations.
   (g) Method of connecting gear set to power source.
8. Service conditions
   (a) Type of load
      Continuous .... Intermittent ....
      Shock .... Reversing ....
      Give duration of loads wherever possible. If a reversing load, indicate direction of operation during major portion of time ....
   (b) Method of lubrication
      Splash .... Forced feed .... Other means ....
9. State unusual conditions such as extreme temperatures, moisture, and abrasion ....
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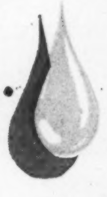

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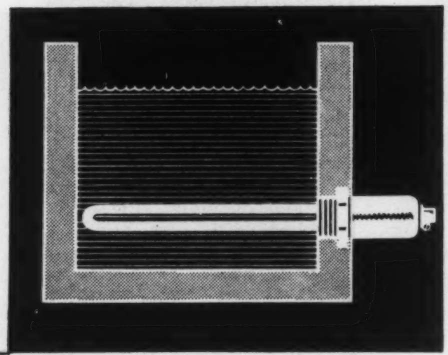

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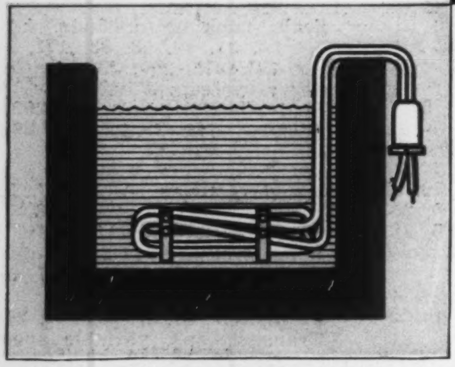

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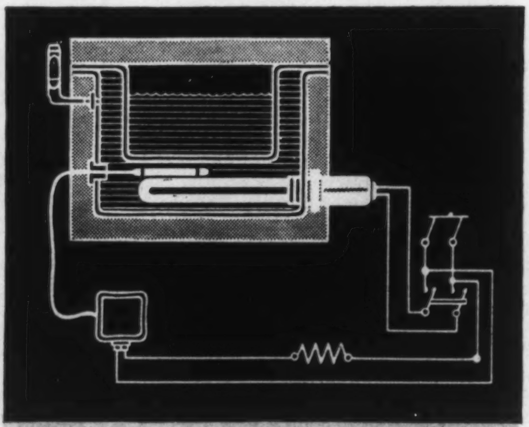

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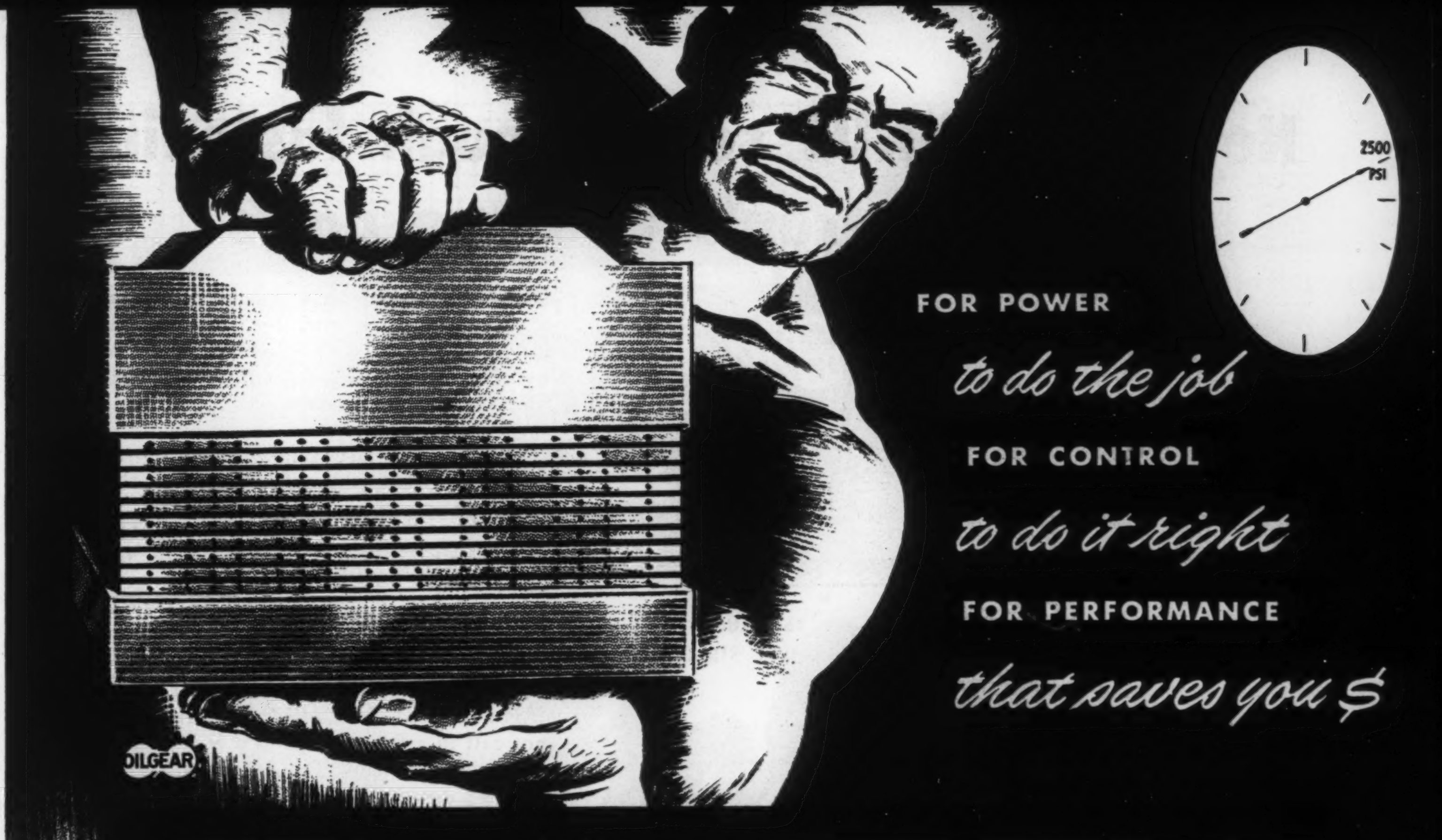


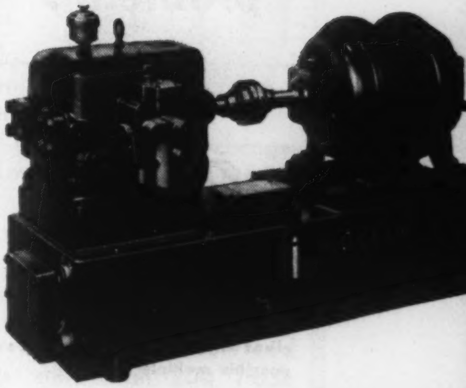
PRESS MANUFACTURERS INSIST ON OILGEAR FLUID POWER

Many outstanding manufacturers of heavy duty presses in every field have standardized on Oilgear tried and proven "Fluid Power" pumps, cylinders and valves.

Oilgear systems provide an adjustable working pressure to suit the work performed . . . a variable ram speed . . . automatic reduction of pump stroke and power input when pre-set pressure is reached . . . maximum pressure indefinitely without excessive heating or power loss. Low maintenance cost and high efficiency coupled with use of power only in proportion to the resistance of the work make their operation very economical. Simple, semi-automatic or full automatic controls are easily applied.

You get controlled, variable high speed for closing and opening press. You can vary the force to suit the material processed. You save a high percentage of power and reduce heat and wear during the curing time. Your Oilgear system will be simple, easy to install, and trouble-free. Investigate these and other operating values inherent in Oilgear pumps, cylinders, and valves. They have proven successful for over a quarter century on tough applications.

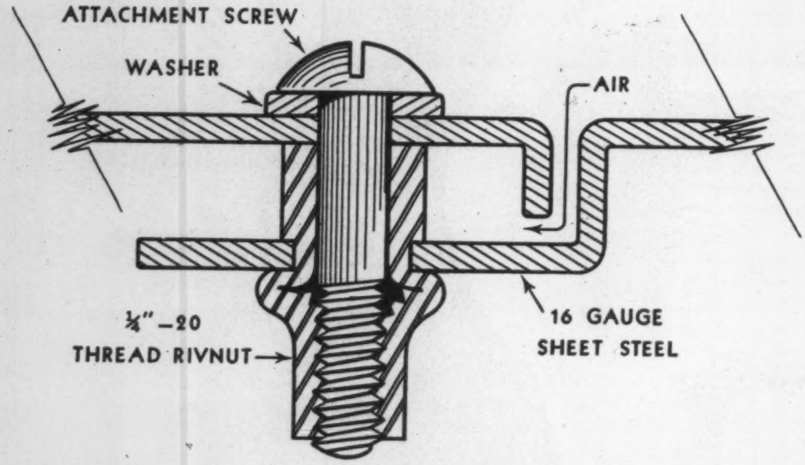
Write for data on typical Oilgear time, labor and money savings . . . on hot plate, molding, forming, straightening and other types of presses used throughout industry. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wis.



Standard one-way variable delivery pump, type D.P. Automatic pressure unloading control, direct-connected electric motor, mounted on reservoir base.

Oilgear Fluid Power

New ¼" RIVNUT solves tough fastening problem—replaces three parts



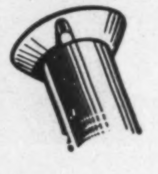
Designers of a new bus engine came up against a tough fastening problem in providing an air vent between two steel sheets of the engine housing. Because it was a semi-blind fastening job, the use of conventional bolts, nuts and spacers would slow production.

They found the answer in spacer-head Rivnuts. The ¼" steel Rivnut was inserted in the 16-gauge sheet steel and upset with power tool by *one* man, working from *one* side. The increased Rivnut head served as a spacer for the second steel sheet, which was firmly anchored by an attachment screw, threaded into the Rivnut.

The ¼"-20 thread Rivnut provided extra strength, improved the design and cut costs. If you're faced with a fastening problem, why not call in a Rivnut engineer? Write the B. F. Goodrich Company, Dept. MD-69, Akron, O.

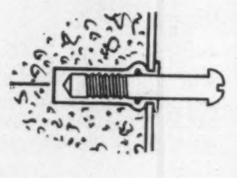
What's your toughest fastening problem?

TORQUE



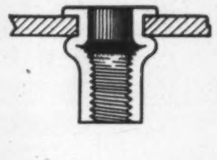
Special Rivnuts with splined shafts or key (above) supply needed torque resistance.

SEAL?



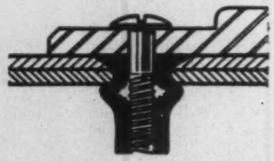
Firm grip of upset Rivnut on material, plus special closed end, gives tight seal.

MATERIAL?



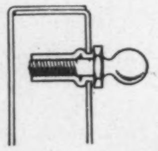
Even in thin materials, Rivnuts provide a secure nut plate with at least six clean threads.

ATTACHMENT?



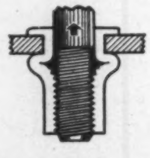
Rivnut serves both as blind rivet and nut plate, makes possible multiple fastening.

FINISH?



Rivnuts can be installed *after* finish, such as paint or porcelain, is applied.

LOADS?



Typical Rivnut thread strength: 6-32—784 lbs.; 8-32—1101 lbs.; 10-32—1220 lbs.*

RIVNUTS

lick them all!

**Figures given for aluminum. Loads for brass and steel Rivnuts about double.*

B.F. Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives applications. Write to The B. F. Goodrich Company, Dept. MD-69, Akron, Ohio.

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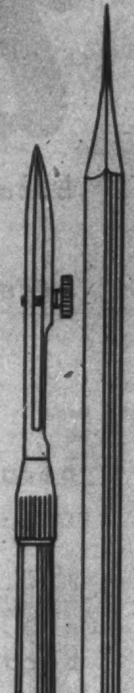

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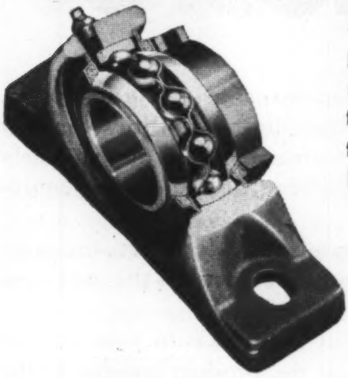
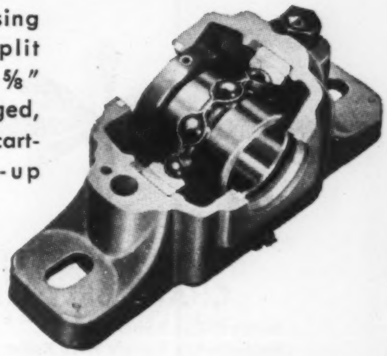


Solid or split housing pillow blocks (solid shown) for shafts 5/8" to 3 15/16"—also flanged, take-up, and hanger blocks.

Series 300 ball bearings

Solid or split housing pillow blocks (split shown) for shafts 5/8" to 3 15/16". Also flanged, flanged cartridge, cartridge and take-up blocks.



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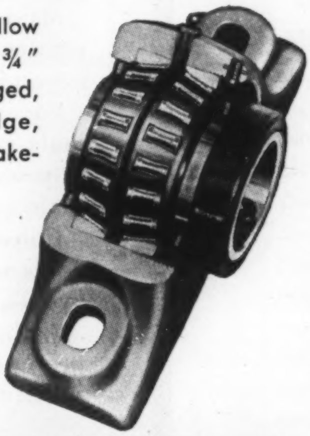
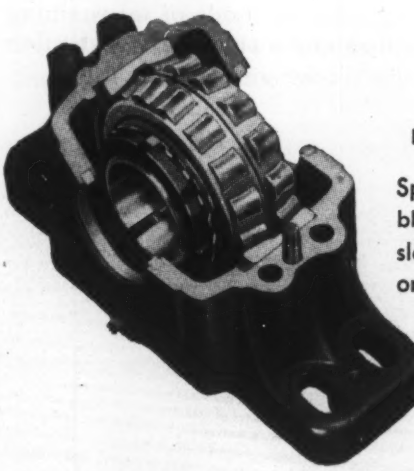
Solid housing pillow blocks for shafts 3/4" to 4"—also flanged, flanged cartridge, cartridge and take-up blocks.



Series 6800-6900 roller bearings



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If you're designing for lower costs, consider these points. Have you thoroughly explored the possibilities for cost reduction and improved performance offered by properly applied power transmission, timing, and conveying equipment?

Perhaps you're using the same basic design . . . the same type equipment for these important functions that has been used for years.

Maybe it's still the best, but you owe it to yourself and your customer to be sure that the product you use is the lowest in cost, consistent with quality and performance.

For example, your design may be overchained. A lighter chain may do the job just as well with important savings to you and the customer. A cast chain instead of a steel chain again may do the job as well at lower cost.

Conversely, your design may be underchained and liable to premature breakdown, resulting in far greater overall cost to you and your customer.

Perhaps you are using other methods of transmitting power or timing operations and a chain drive can effect substantial savings in space, costs and weight.

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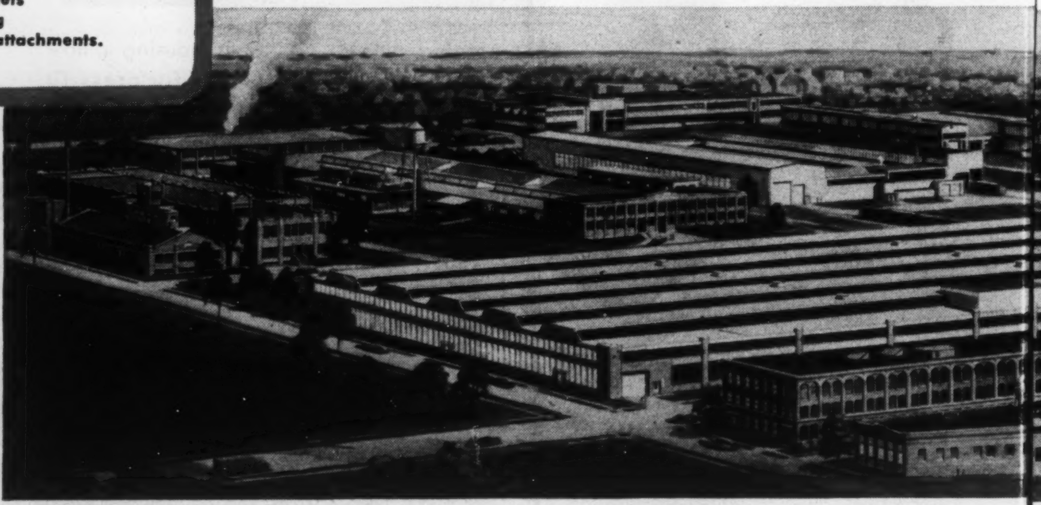
and a complete line of chain attachments.



CHAIN BELT COMPANY

HERE*

costs?

There is no one best or stock answer to the problem of transmitting power, timing operations or conveying materials. That is why we at Chain Belt Company feel that we can be of practical assistance to you in designing for lower cost. Because we manufacture a *complete line of chains,* both cast and steel, we can help you select the chain that is exactly right for your machines.

If the operating conditions are such that a cast chain is indicated, we have the exact chain that will best fit the need. Where speeds and horsepower requirements demand a finished steel roller chain, again our complete line contains the answer.

Our Field Engineers plus our Plant Engineers are well equipped to work with you in the selection and application of Rex and Baldwin-Rex Chains for your designs. In many instances they have been able to help effect substantial savings and increase machine efficiency through the flexibility of our complete line and their years of practical experience. Call or write the Chain Belt Company Field Office near you or write direct to Chain Belt Company, 1643 West Bruce Street, Milwaukee 4, Wis.

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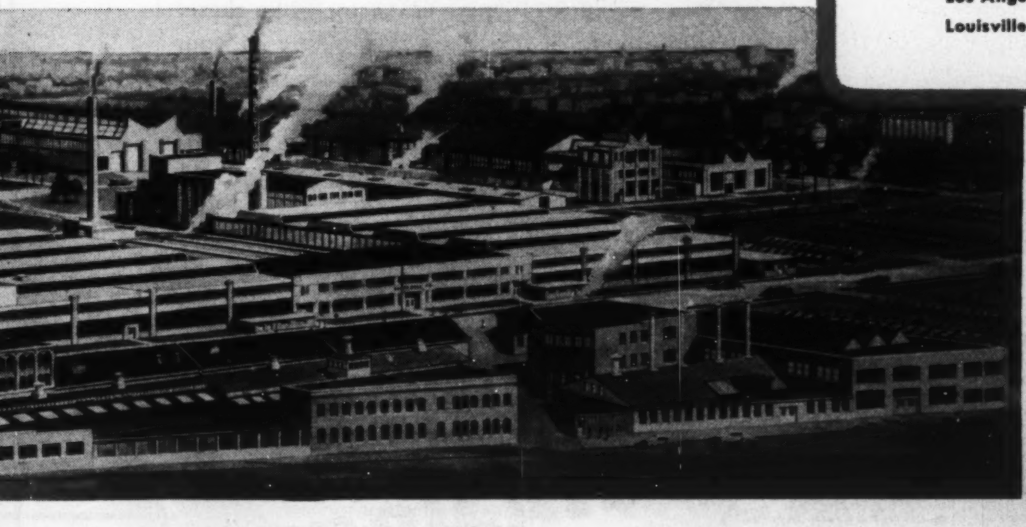

Here is a composite view of Chain Belt Company's manufacturing facilities. From these plants comes a line of chains unsurpassed for completeness . . . chains that have been serving industry everywhere for over 50 years.

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The survey shows that the yearly average cost of periodically lubricated motors was $270 for every hundred motors installed.

On lubrication cost alone, Life-Line motors saved this $270. That's because Life-Line requires no periodic lubrication—no added lubrication of any kind.

The survey also indicates that the yearly outage cost per hundred motors, for repairs and lost machine and man-hours, was $960.

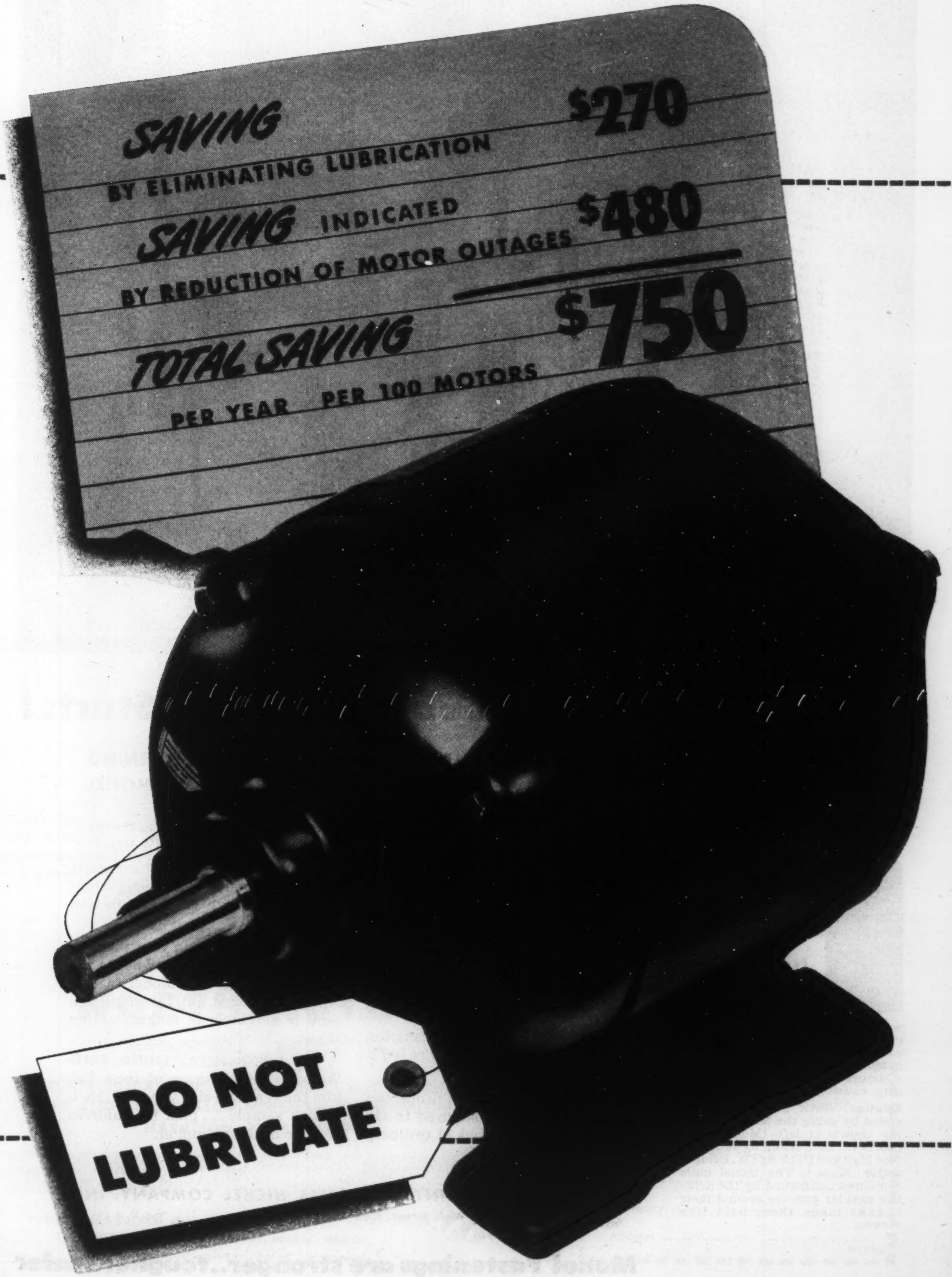
The record of 500,000 Life-Line motors in service, to date, indicates a failure rate averaging less than half that of conventional motors covered by this survey. This means over 50% indicated reduction in motor outage costs—in short, a possible saving of $480 per year with Life-Line.

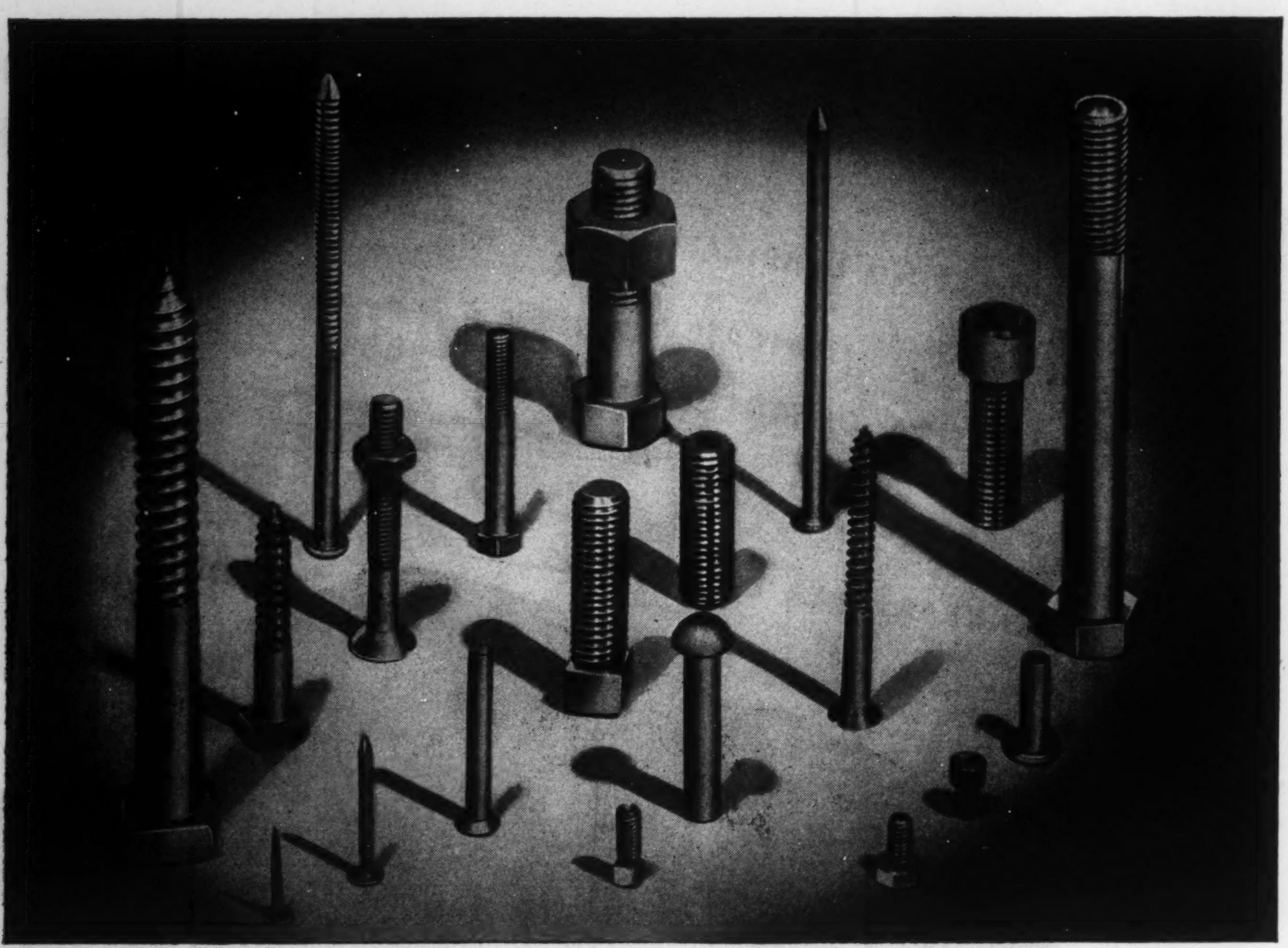
Add these savings—$270 for lubrication plus $480 for outages—and the result is $750 per hundred motors per year.

Can you afford to pass up savings like these? Get the facts on the savings possible in your plant. Ask your nearby Westinghouse representative for a copy of B-4321 "How to Cut Motor Costs $750". Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

J-21508-D

Westinghouse
Life-Line
Motors


SAVING $270
BY ELIMINATING LUBRICATION
SAVING INDICATED $480
BY REDUCTION OF MOTOR OUTAGES
TOTAL SAVING $750
PER YEAR PER 100 MOTORS
DO NOT LUBRICATE



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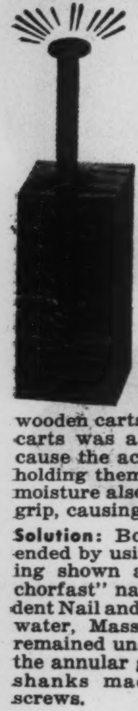

How A Textile Company Put Monel Fastenings To Work

Problem: Piece goods, dripping with a sulfuric acid solution, were being transported in wooden carts. Maintenance of the carts was a constant chore, because the acid attacked the nails holding them together. Continual moisture also weakened the nails' grip, causing them to "back out."

Solution: Both problems were ended by using the Monel fastening shown at left (Monel "Anchorfast" nail, made by Independent Nail and Packing Co., Bridgewater, Mass.). The Monel nails remained unaffected by the acid; the annular grooves around their shanks made them hold like screws.

For most jobs ordinary fastenings are adequate.

But there are plenty of jobs where you need extra protection against rust . . . corrosion . . . shock . . . overstressing. . . vibration. . . heat. . . cold.

For those jobs you need the protection of *Monel**.

Just look at the "extras" you get from Monel fastenings.

They resist corrosion by caustics, most acids, salt water. They're 100% rustproof.

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And if extreme temperatures must be endured, you'll find Monel fastenings safe at high heat or sub-zero cold.

How many places in your plant or product do you want (*and need*) the extra advantages of Monel fastenings? Remember, *any* fastening you need is available in longer-lasting Monel.

TEST A MONEL FASTENING, FREE! Write to Bob Johnson of Inco. Tell him the type and size you need. He'll send a sample . . . plus the address of your nearest supplier.

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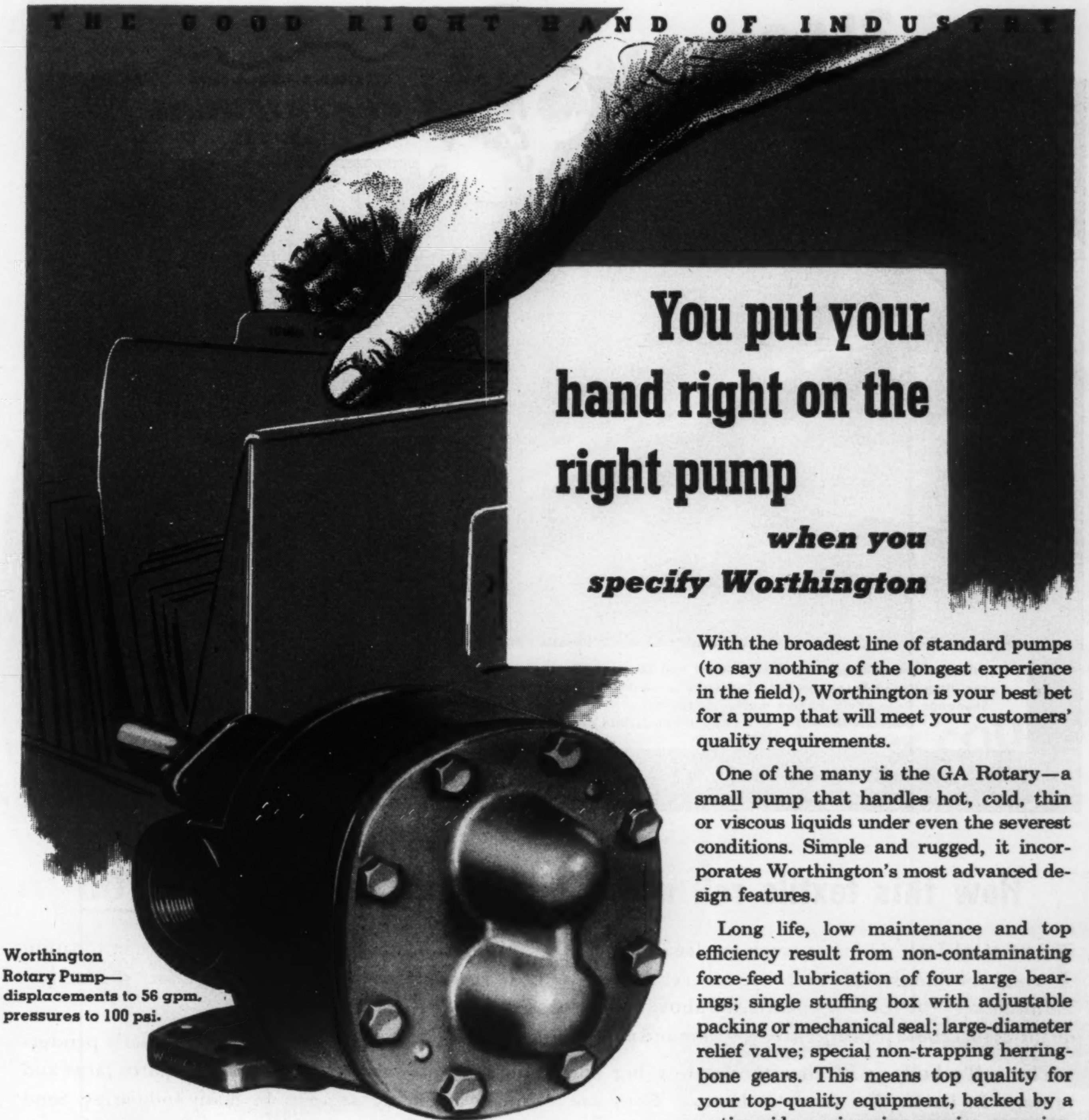
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That's why Shenango-Penn is continually producing symmetrical, annular and tubular parts, large and small, for many services in many industries. Send for free bulletins on either ferrous or non-ferrous made-to-order centrifugal castings or on *centrifugally cast* bronze bushing stock in standard sizes.

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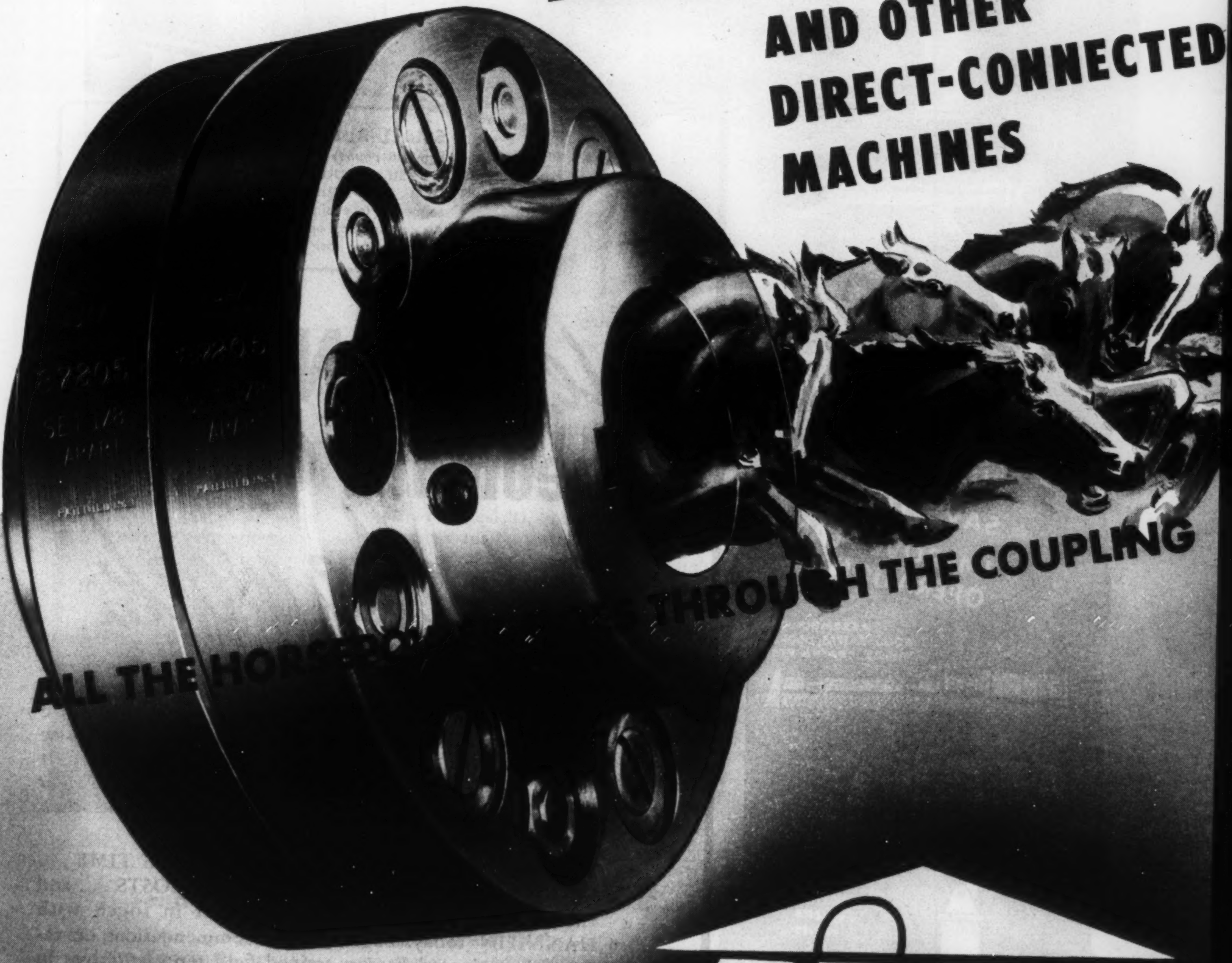

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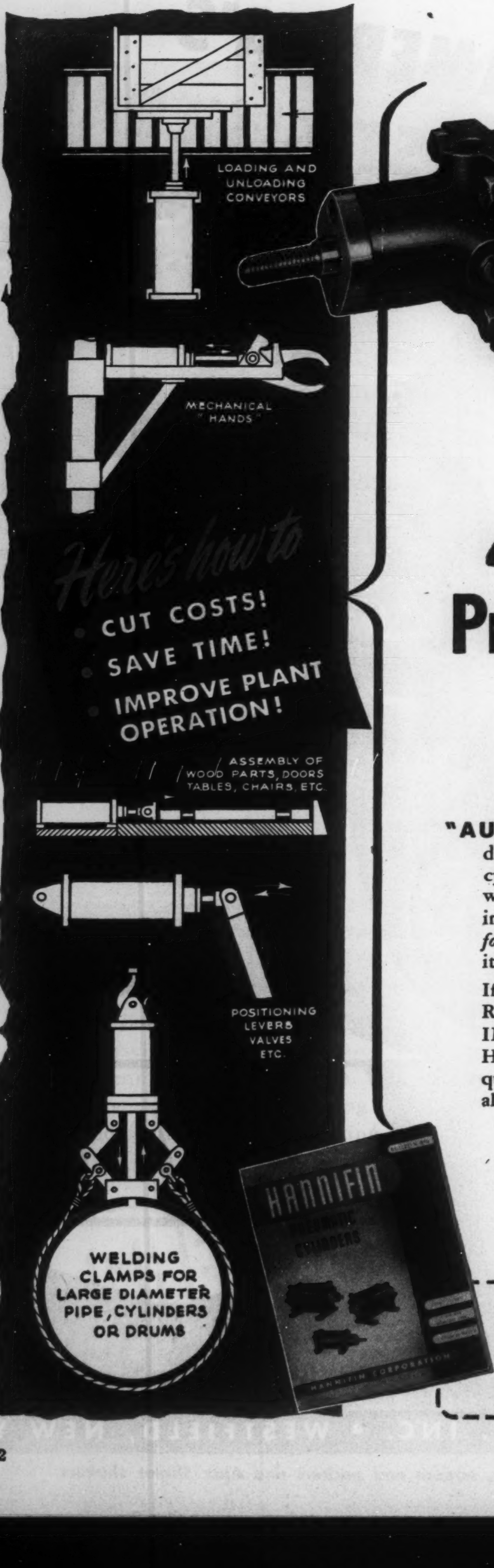
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How to cut sealing costs with lathe-cut gaskets

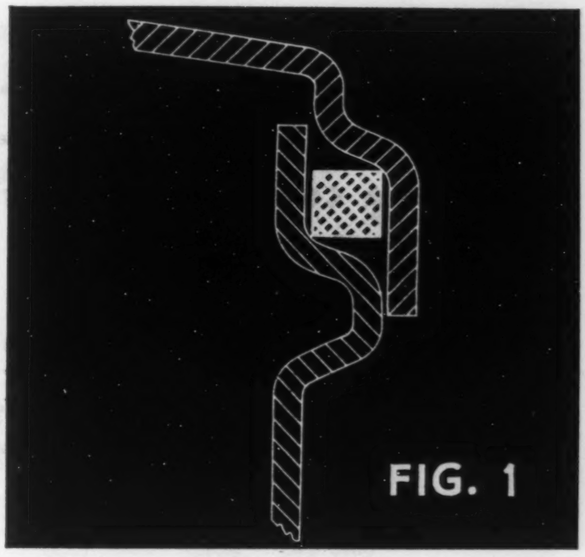


FIG. 1

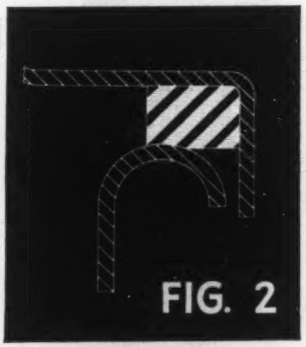


FIG. 2

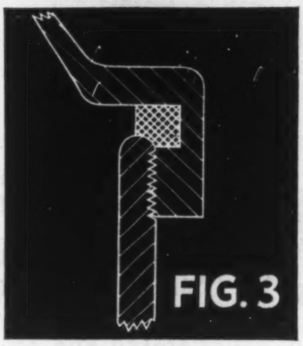


FIG. 3

Sealing costs frequently can be reduced through using small section, lathe-cut gaskets. When made of the right sealing material, these gaskets permit the use of smaller machined flanges—or even stamped or spun metal flanges. Thus, by careful selection of gasket materials, the cost-saving features of such design changes can be realized to the fullest extent.

Lathe-cut gaskets, made from one of Armstrong's many cork-and-rubber compositions or straight rubber compounds, will provide an effective, economical seal in most applications of this type.

These square or rectangular section rings are used even when a round or complex section gasket seems to be required. Ordinarily, a cork-and-rubber or rubber gasket will deform sufficiently under pressure and afford an effective, low-cost seal.

For example, the cost of sealing chlorinated oils was reduced by replacing a cast iron flange with the pressed steel construction in figure 1. The lathe-cut gasket made of an Armstrong straight synthetic rubber deforms under pressure to provide a tight seal at lower cost.

The rolled edge flange in figure 2 also replaced a cast iron unit. In this case, an Armstrong's cork-and-rubber lathe-cut gasket was used. Because cork-and-rubber is truly compressible, it conforms to the rolled edge without slipping out of place.

In figure 3, a lathe-cut gasket, made of an Armstrong synthetic rubber compound, replaced an expensive molded part. To facilitate removal of the screw-on cover, the contact area of the gasket was reduced by one half. Yet a tight seal was maintained because the gasket was firmly seated on the round edge.

Armstrong's cork-and-rubber and rubber compounds may help reduce your sealing costs. We recommend that you discuss your application with an Armstrong representative. Methods and materials he suggests may enable you to do a better sealing job at lower cost.

Send for this Gasket Handbook

You'll find useful application and specification data in the new, enlarged 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, cork composition, and fiber sheet sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

For your free copy, fill in coupon at right and mail today.

ARMSTRONG'S
GASKET AND SEALING
MATERIALS

ARMSTRONG CORK CO.
Gaskets and Packings Dept.
5106 Arch Street, Lancaster, Pa.

Please send me at once a copy of the new 24-page booklet, "Armstrong's Gasket and Sealing Materials."

NAME..
COMPANY..
ADDRESS...
CITY..STATE..................

ARMSTRONG'S
GASKETS • PACKINGS • SEALS

Easier to Install

THAN A COMPRESSION FITTING

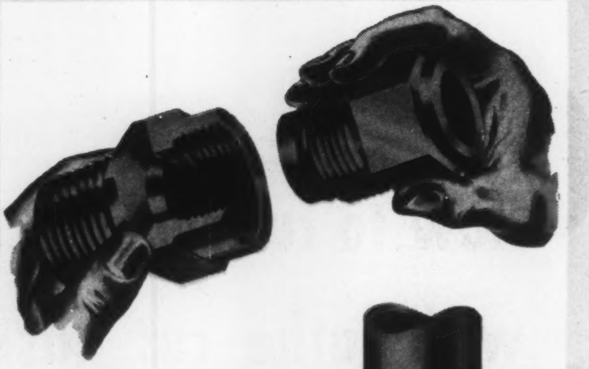
Stronger

THAN ANY OTHER FLARE FITTING

SCOVILL

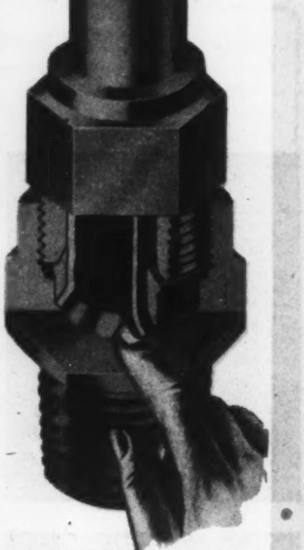
Uniflare

Here, in one fitting, are the best features of other fittings with none of their disadvantages



SCOVILL'S UNIFLARE has only two parts—body and male-threaded nut. Goes on even *easier than a compression* fitting . . . and has far greater strength.

SCOVILL'S UNIFLARE provides the recommended 37 degree flare without weakening the tube. Has *greater strength than other flare* fittings . . . and it's self-flaring.



HOW DOES IT WORK?

One turn of the nut shears off the collar, clamping it onto the tube; further tightening flares the tube and makes the seal. No flaring tool needed . . . no separate flaring operation . . . no cracked tubing to worry about.

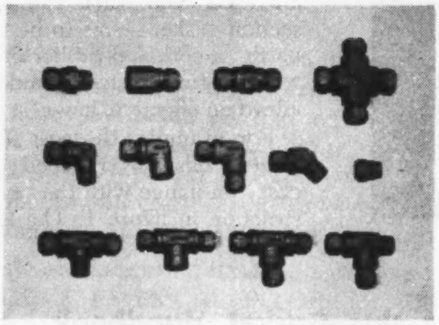
WHY IS IT STRONGER?

Special brass alloy permits more tightening, resists vibration. The tube will burst before UNIFLARE will leak. Yet UNIFLARE can be taken apart and reassembled many times.

ADVANTAGES TO DESIGNER

Specify lighter weight, less costly tubing . . . Save assembly time without sacrificing efficiency . . . Be sure UNIFLARE will hold up against vibration . . . Allow for repeated disassembly and reassembly.

Recommend for refrigeration, etc.—due to "anti-frosting" construction and Dryseal threads.



UNIFLARE is available in a complete range of sizes from ⅛ in. through 1 in. and in all standard shapes. Fully tested and approved by the Underwriters' Laboratories, Inc.

Investigate UNIFLARE for oil, air, water or hydraulic lines. Write on company letterhead for a working sample. Address Screw Machine Products Division, SCOVILL MANUFACTURING COMPANY, 50 Mill Street, Waterbury 91, Conn.

A PRODUCT OF

SCOVILL

SCOVILL

Uniflare The Complete, Self-flaring Tube Fitting

VOLTS 110 120 AC OR D.C.
WATTS-35
Oster
MODEL 10
Progienic
ELECTRIC CLIPPER
NO.-10 2434
PATENTS 1956042—OTHERS PEND.
JOHN OSTER MFG. CO.

Oster
MADE IN U.S.A.
Progienic

"Supreme in Smoothness"

with GEARS by . . .

FRACTIONAL HORSEPOWER GEARING
GS

WHENEVER "Supreme Smoothness" is a rigid requirement, that's when it pays to use Fractional Horsepower Gearing by G.S. The John Oster Co. of Racine, Wisconsin, like so many other critical buyers, specifies G.S. Small Gears for UNIFORM *Smoothness* of operation and for the long, economical service they give. If efficient *low cost* production runs of Fractional Horsepower Gearing is an essential requirement in your business by all means come to *"Small Gear Headquarters"* for the kind of quality and service you need. It is no happenstance that industry uses more Fractional Horsepower Gearing by G.S. than any other kind!

SEND FOR OUR CATALOG BULLETIN

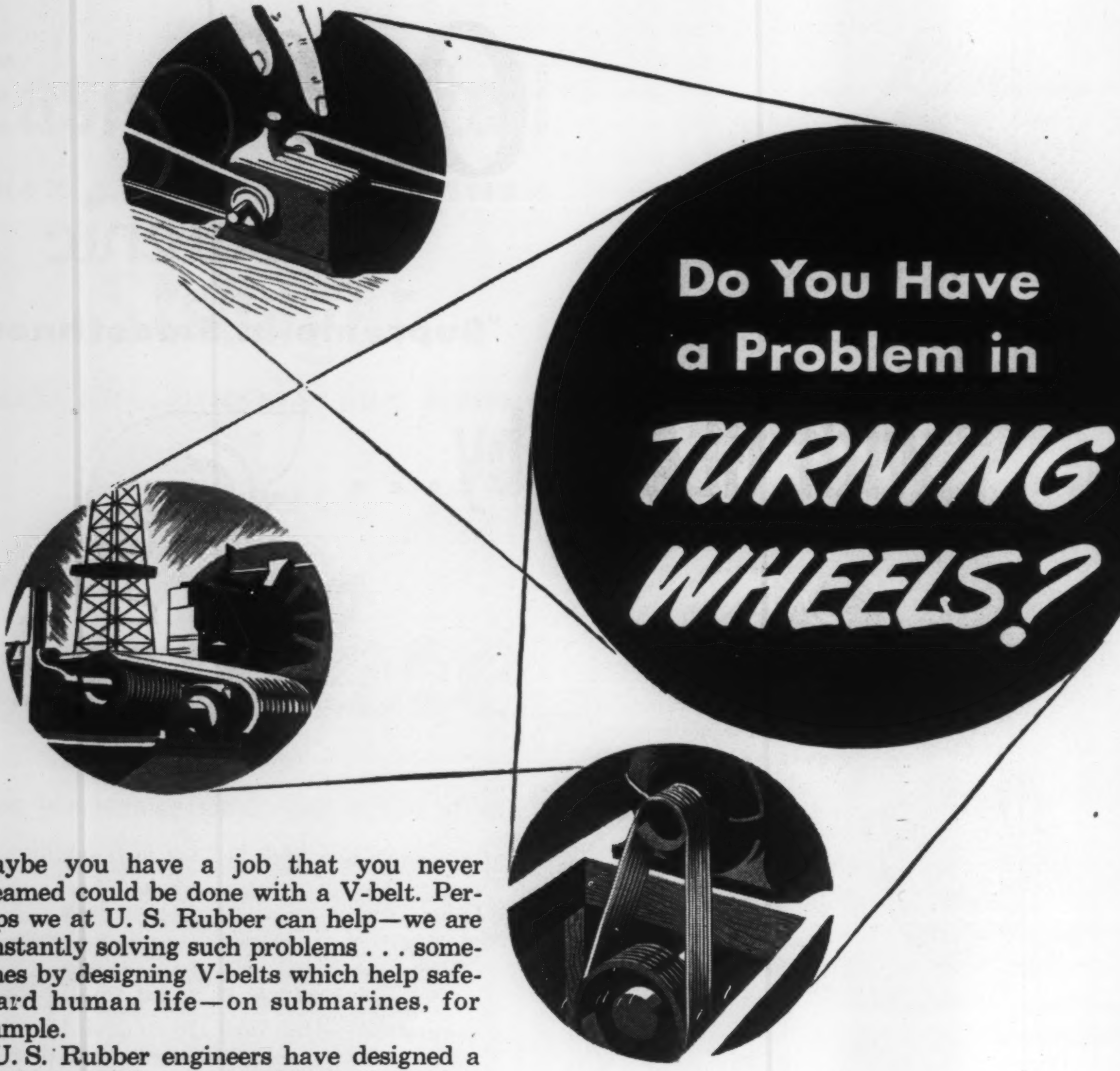
IF IT'S A SMALL GEAR PROBLEM
Ask
GEAR Specialties

GEAR Specialties

Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding
2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS



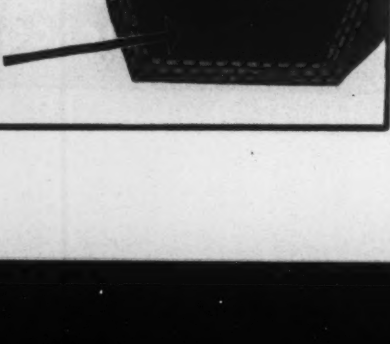
Do You Have a Problem in TURNING WHEELS?

Maybe you have a job that you never dreamed could be done with a V-belt. Perhaps we at U. S. Rubber can help—we are constantly solving such problems . . . sometimes by designing V-belts which help safeguard human life—on submarines, for example.

U. S. Rubber engineers have designed a V-belt as small as 4¾ inches in circumference, and as large as 55 feet. They have solved such a wide range of V-belt problems that today, if you want "a special" in a hurry, chances are it can be obtained without making a new mold.

For more information, write Mechanical Goods Division, United States Rubber Company, 1230 Avenue of the Americas, New York 20, N. Y.

U. S. RAINBOW
V-BELTS
WITH THE EQUA-TENSIL CORD SECTION



Top Rubber Cushion in closely-engineered balance with the lower section . . . to keep cool under constant stretch and turn.

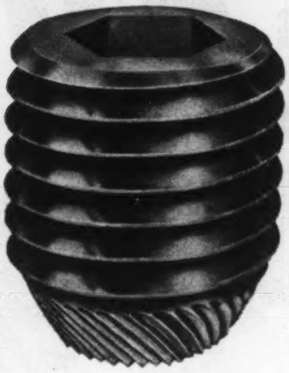
Equa-Tensil Cord Section—all cords scientifically placed, each pulling its share of the load.

A sturdy level cushion for the Equa-Tensil Cord Section. Provides structural firmness for V-grooves and over the flat pulley of V-to-flat drives.

MADE BY

U.S.RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY



The patented Knurled Cup Point of this popular "UNBRAKO" Socket Set Screw makes it a Self-Locker, because the edges of the counter-clockwise knurls positively prevent creep, regardless of the most chattering vibration. *"It won't shake loose!"*

Pat. & Pats. Pend.

The patented Knurled Threads of this "UNBRAKO" Socket Set Screw are swaged—making it a most excellent Self-Locker for applications requiring cone, oval, flat or other points except cup, and for use with hardened shafts. *"It won't shake loose!"**

Pat.

UNBRAKO

SELF-LOCKING SET SCREWS

"...THEY WON'T SHAKE LOOSE"

Machine failure from any cause is expensive—in downtime, repair costs, lowered production, poor deliveries and loss of customer goodwill. Frequently such failure is caused by the loosening of set screws holding vital machine parts together.

UNBRAKO *Self-Locking* Set Screws won't shake loose! Their exclusive *knurling* makes them exceptionally vibration-resistant, prevents "creep" and subsequent loosening of the screws. They "stay put", even under the most chattering vibration.

UNBRAKO *Self-Locking* Set Screws can be real "Vibration Insurance" for *your* production machinery. And remember, they make an impressive selling point when you use them on your finished products.

Our folder 658-1 gives you further details. Write for yours today!

Knurling of Socket Screws originated with "Unbrako" in 1934.

*These screws are not carried in stock. Prices are available on application.

SPS

STANDARD PRESSED STEEL CO.

BOX 102 JENKINTOWN, PENNSYLVANIA

"Serving Industry continuously since 1903 through Industrial Distributors"

NEW SHEAVE

Vari-Pitch
AUTOMATIC
SHEAVE
TEXROPE V-BELTS
KEPT IN PROPER
TENSION AUTOMATICALLY

Another *Texrope* Engineering Triumph

AUTOMATIC SHEAVE DOES COMPLETE JOB!

- ★ Instant speed control at lower cost than ever before
- ★ Covers most speed changing needs from 3 to 20 hp
- ★ Extremely simple — one sheave does all
- ★ No need to stop machine or take load off
- ★ Infinite variation over approximately 200% speed range
- ★ Easier starting—sheave adjusts to load.

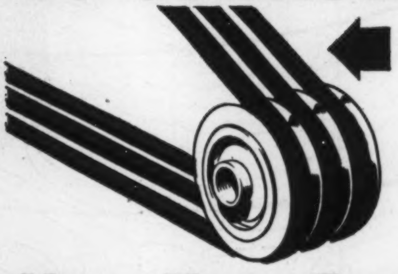
HERE IS THE SIMPLEST, lowest cost way ever devised for changing machine speeds without stopping the machine. Simply move the motor forward to increase speed and move it back to decrease. The new *Vari-Pitch* Automatic Sheave adjusts to the new belt position *automatically.* Other parts of drive are standard *Texrope* drive components.

ALLIS-

Originators of the

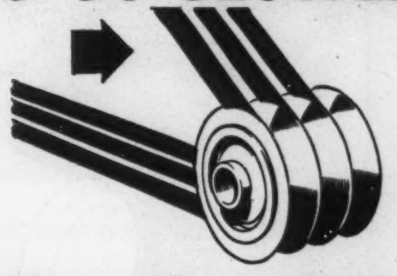
Changes Speed Without Stopping

TO GO FASTER



Move Motor Forward

TO GO SLOWER



Move Motor Back

------ONE HAND DOES IT... *While Motor is Running*

This new method of speed control will lower drive costs in nearly every industry where variable speed drives are used. It will make possible savings in many industries where variable speed is not now used because of high initial cost.

Find out now how this new idea in speed control can save money for *you.*

For details see your A-C Authorized Dealer or Sales Office or write for Bulletin 20B7223. *Texrope* and *Vari-Pitch* are Allis-Chalmers trademarks. A-2708

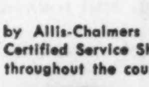
ALLIS-CHALMERS, 1001A SO. 70 ST.
MILWAUKEE, WIS.

CHALMERS

Multiple V-Belt Drive for Industry

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.



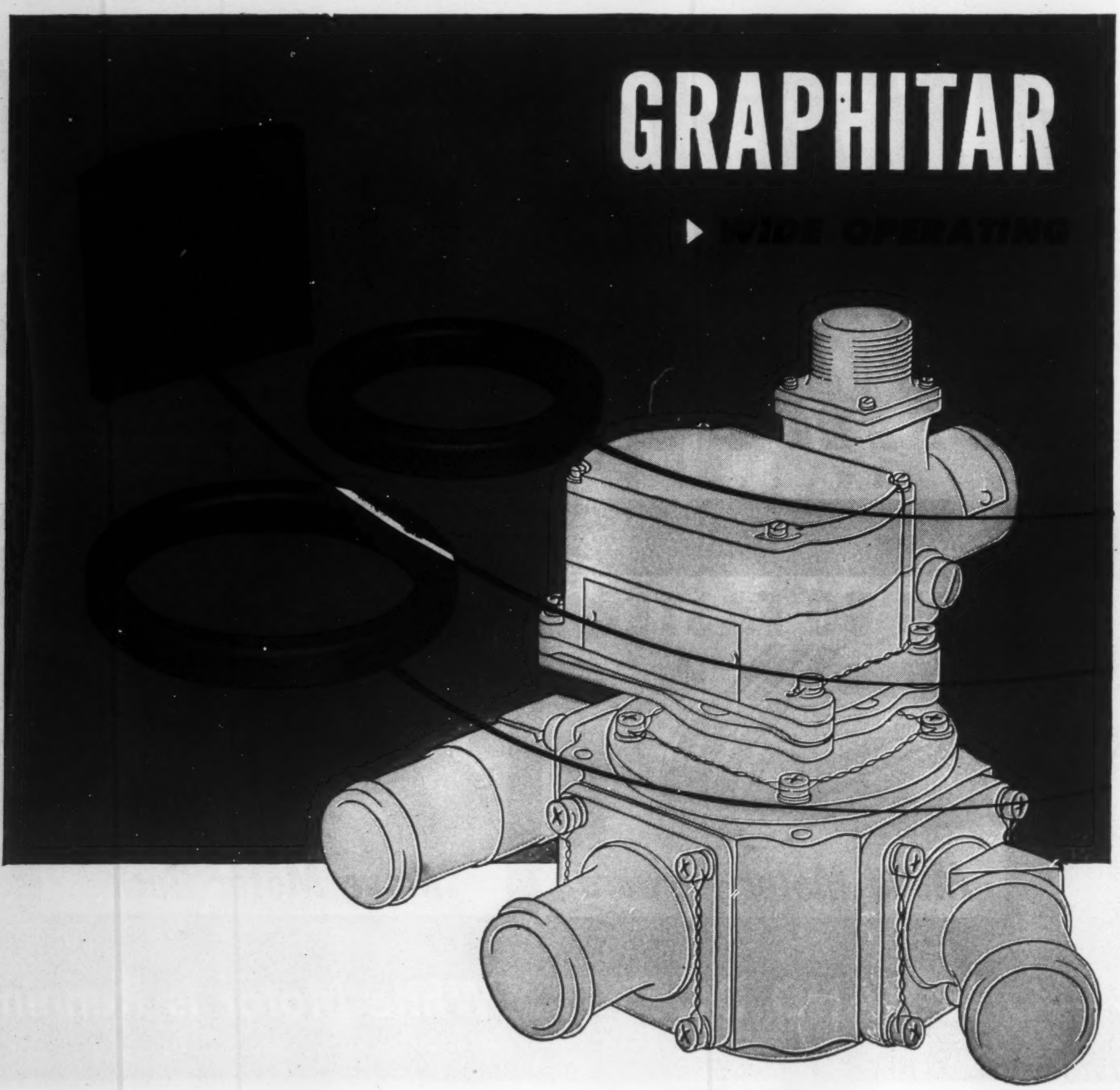
MOTORS — ½ to 25,000 hp and up. All types.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

PUMPS — Integral motor and coupled types. Sizes and ratings to 2500 GPM.

GRAPHITAR

▶ WIDE OPERATING

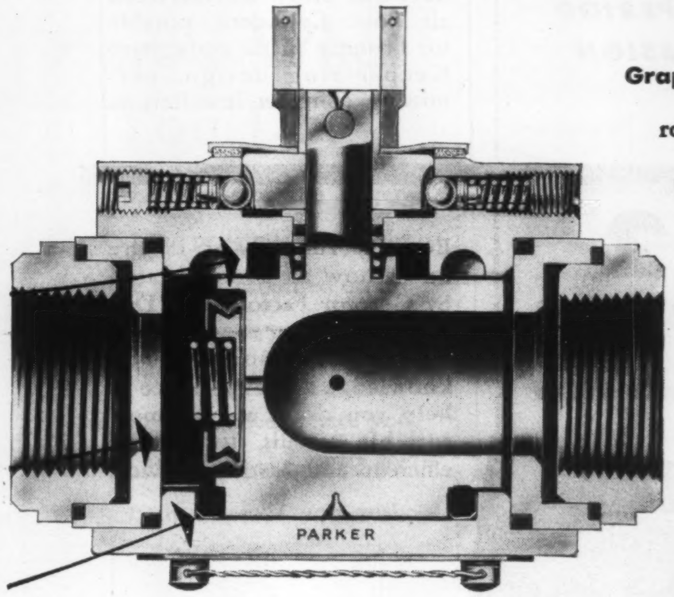


The many unique characteristics of Graphitar make it an invaluable material in many industries. Graphitar is extremely light, mechanically strong, and inexpensive. It finishes to tolerances as close as .0005″ and laps perfectly as a bearing, bushing and seal. Graphitar is unaffected by temperature extremes, and is impervious to strong acids and chemicals. It won't expand, contract, corrode or scale. It needs no lubrication because it is in itself a lubricant. You are invited to send your sketches for study by our engineers. They may be able to suggest Graphitar parts that will solve a mechanical problem for you.

Write for our new 64-page Catalog now ready for mailing.

THE UNITED STATES GRAPHITE COMPANY

GIVES PARKER SELECTOR VALVES RANGE UNDER EXTREME CONDITIONS



Graphitar sealing discs and bearings play important roles in the Parker Aircraft Fuel Selector Valves that insure positive, split-second changes of fuel supply under the most extreme operating conditions. The Graphitar sealing discs constitute ideal lapped port seals for life of the valve. They permit the valve to operate from a range of 0 to 50 psi with low and uniform turning torque, consistent under extreme conditions: wet or dry, new or old, from –65° to 160°F. ↗ ↗ ↗ Two Graphitar bearings permit the valve rotor to be turned smoothly without lubrication. ↗ ↗ ↗ Parker valves control the flow of hydraulic oil, engine oil, water injection systems, large air and vacuum lines as well as aviation gasoline and kerosene. They are applicable as shut-off valves for jet engines in high temperature air lines (up to 450°F.) or as high pressure (500 psi) shut-off valves.

GRAPHITAR

(CARBON-GRAPHITE)

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

WHAT MAKES UP A *Good* *Air Circuit?*

1

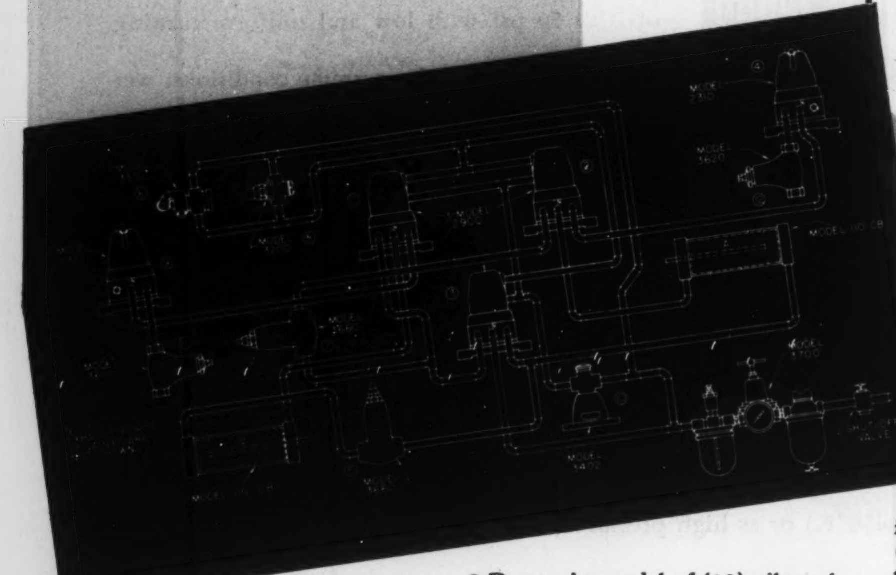
VALVES, CYLINDERS OF SUPERIOR DESIGN

Gerotor meets this requirement with equipment designed by foremost engineers in the air field. Compactness of 4-way valves prevents fouling or leaking; large, convenient pipe connections allow unrestricted air flow. Cylinders, notable for absence of tie rods, have Keeper ring design, permitting compact installation.

2

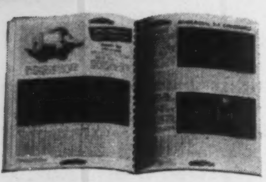
KNOWLEDGE OF APPLICATION

Equally important is the know-how as demonstrated by Gerotor Factory and Distributor Representatives. These men possess the knowledge and experience to help you draw up the most suitable circuit to furnish efficient and lasting service.



AIR EQUIPMENT ON AN AUTOMATIC LATHE FOR CLAMP, TURNING AND CUT-OFF

● Depressing pedal of (10) pilot valve exerts pressure on pilot end of (1), (2) and (3) pilot operated 4-way valves. Air flows from valve (3) to blind end of clamp cylinder (A). Piston moves out rapidly, the air from rod end being exhausted thru (4) cam operated 4-way valve. When clamp cylinder rod (A) depresses cam of valve (4), exhaust air from cylinder is restricted (12), providing for a slow approach. When clamp cylinder engages work, pressure in supply line increases, causing sequence valve (5) to open. Air flows into blind end of cut-off tool cylinder (B) and a similar action takes place thru the out-stroke, by means of (9) and (11). After the cut-off, cylinder rod depresses cam of (6) pilot valve which, by pilot pressure, reverses valves (1), (2), and (3). Air line is then connected to the rod end of cylinder (B) and retracts cut-off tool. After cylinder completes return stroke, pressure builds up in supply line connected to sequence valve (7). Pressure opens valve (7) and allows air to rod end of clamp cylinder. After it retracts, cycle is completed. Pilot valve (8) permits interruption of cycle to retract cylinders.



Get Gerotor Catalog
Sections No. 53 and No. 301
describing air valves and cylinders
Write to
GEROTOR MAY CORPORATION
Dept. MD-6, Baltimore 3, Maryland

WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with* **GEROTOR**

Wichita City Library

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IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

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Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want—whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

Please send further information on the following advertisements in this issue:

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ADDRESS ______________________

CITY ______________________ STATE ____________

MD6-49

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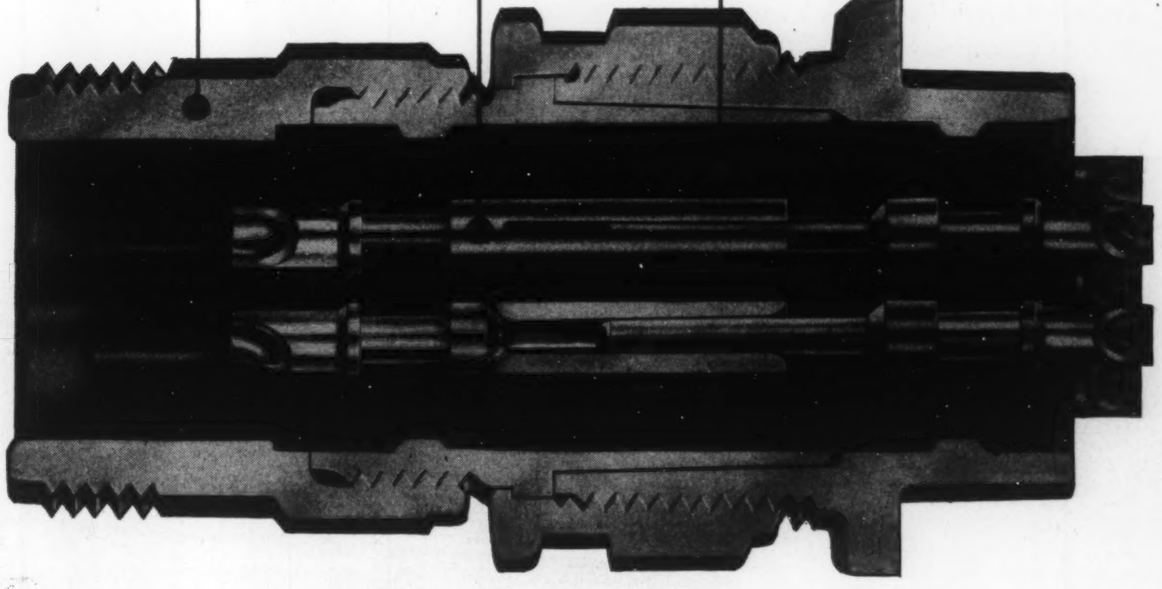
JUST LOOK AT THESE FEATURES . . .

SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.

CONTACTS
High current capacity . . . Practically no voltage drop. No additional solder required.

SCINFLEX ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.



BENDIX-SCINTILLA

ELECTRICAL CONNECTORS

the Finest money can buy! Contacts that carry maximum currents with a minimum voltage drop are only part of the many new advantages you get with Bendix-Scintilla* Electrical Connectors. The use of "Scinflex" dielectric material, an exclusive new Bendix-Scintilla development of outstanding stability, increases resistance to flashover and creepage. In temperature extremes, from −67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—and that means lower maintenance costs and better performance.

*TRADEMARK

CHECK THESE OTHER ADVANTAGES

• Moisture-proof, Pressure-tight • Radio Quiet • Single-piece Inserts • Vibration-proof • Light Weight • High Insulation Resistance • Easy Assembly and Disassembly • Fewer Parts than any other Connector • No additional solder required

WRITE DIRECT TO
THE SALES DEPARTMENT
SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

BENDIX SCINTILLA

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, New York

$18,000,000 set of tools for the

CRUCIBLE first name in special purpose steels

hot and cold rolled **STAINLESS SHEET AND STRIP**

MASTER mechanic

When a *master* mechanic gets new tools, expect master workmanship. And when CRUCIBLE, *master* producer of tool, alloy and specialty steels, designs an $18,000,000 mill specifically for hot and cold rolled stainless sheet and strip, you can rightly expect the best that modern facilities and generations of *specialty product* leadership can provide.

For here, at CRUCIBLE'S new Midland Mill, is an entirely new concept in stainless sheet and strip production . . . here, for the first time, stainless sheet and strip are made as *specialty products*, by specialty production methods, in a mill built from the ground up for this purpose. Here at Midland are no mills designed for carbon steel production, re-powered for the heavier duty of rolling stainless, but $18,000,000 worth of *brand new* equipment, designed and built for *modern* hot and cold rolling of stainless steel – in widths from ½" to 50" inclusive, and in all gauges, grades and finishes.

This is important news to every designer and fabricator of stainless steel products. For CRUCIBLE, pioneer in stainless steel since its inception, now offers *a completely integrated* line–sheet, strip, plates, bars, tubing, wire, forgings and castings.

In short, you can turn with every confidence to the *first* name in special purpose steels for *every* form of stainless. One of the largest and most highly specialized technical forces in the steel industry is at your service for specific application advice. And there are comprehensive data sheets available for all grades. Your inquiry will be welcomed.

CRUCIBLE STEEL COMPANY OF AMERICA, Chrysler Building, 405 Lexington Ave., New York 17, N. Y.

Branches, Warehouses, and Distributors in Principal Cities. Consult your Telephone Directory or Thomas' Register for Nearest Office.

HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEEL

Using Eaton Springtites or Sems frees hands—saves motions—making continuous production possible. Only 3 motions for a complete assembly instead of 8.

Not using Springtites or Sems requires many extra motions—causing delay, loss of parts, and reduced production all along the assembly line.

The Camera Doesn't Lie . . .

here's how EATON *Springtites* and *Sems* reduce costs

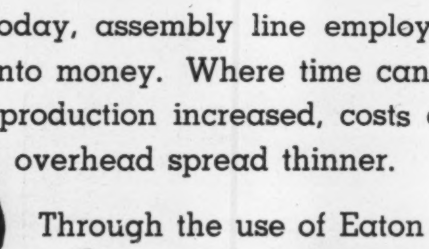
Today, assembly line employees' time runs into money. Where time can be saved and production increased, costs are reduced—overhead spread thinner.

Through the use of Eaton *Springtites* or *Sems* a correctly-engineered unit is assured with a minimum of motions. The intangible savings in paper work, automatically-balanced inventories and elimination of lost parts cuts overhead — saves money.

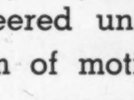
We can prove what these savings mean to you in dollars and cents. Write for engineering data.

RELIANCE SPRING LOCK WASHERS automatically keep bolts, nuts, screws, tight under constant tension — compensate for wear and developed looseness. All sizes and types. Write for Spring Lock Washer bulletin.

RELIANCE RINGS — snap, bearing, lock and retainer — form strong shoulders on shafts or in counter bores and on outer races of bearings. Speed production, cut costs — save time and material. Write for engineering bulletin.



Springtites

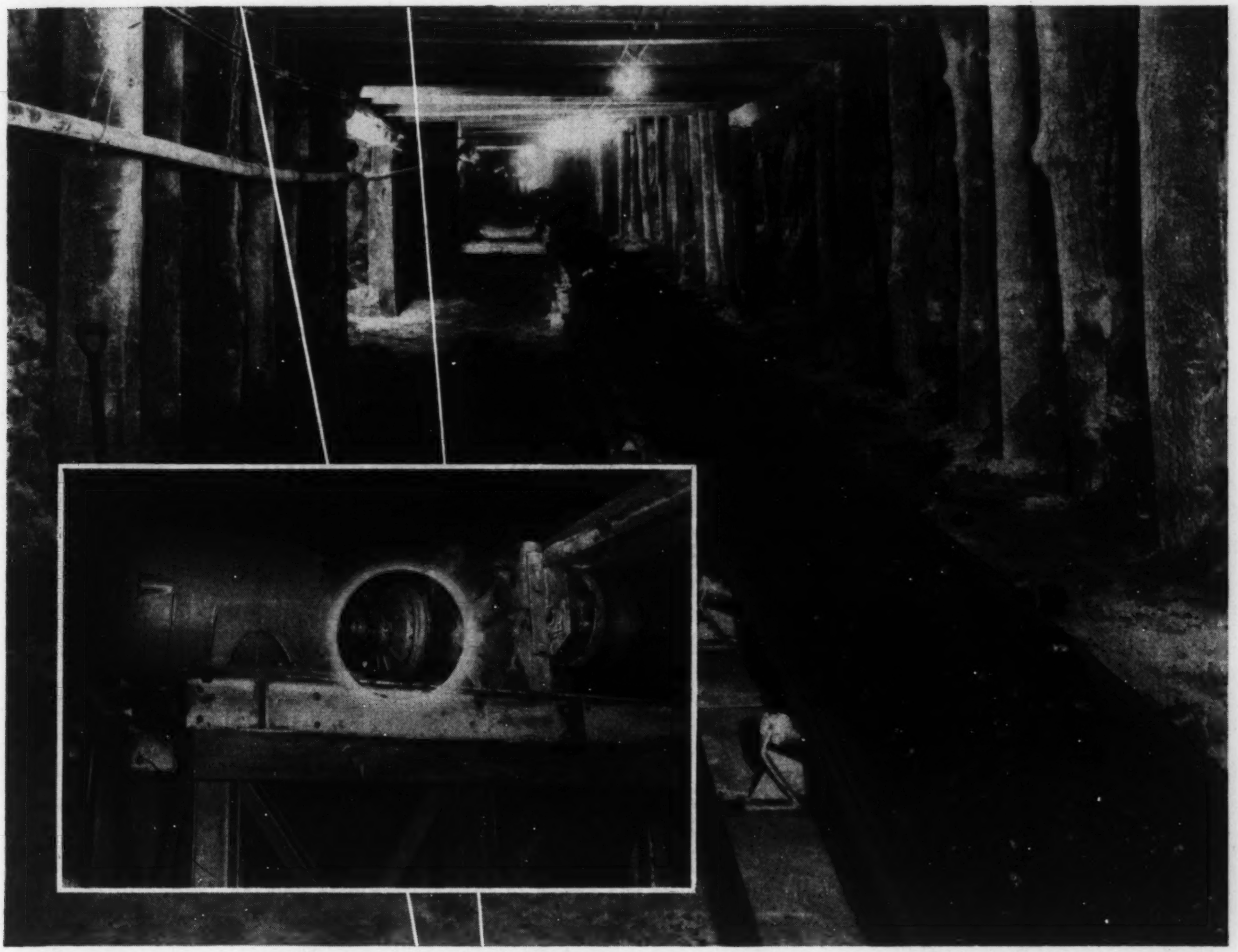


EATON

EATON MANUFACTURING COMPANY

RELIANCE DIVISION; MASSILLON, OHIO

Sales Offices: New York, Cleveland, Detroit, Chicago, St. Louis, San Francisco, Montreal



Taming a River of Coal . . .

From 85 feet below the surface of the earth to the top of a mine tipple, this 500 foot conveyor system carries more than 2800 tons of high-grade bituminous coal every day.

Taming this river of coal on its long journey upward is the job assigned to a Twin Disc 14 inch steel Hydraulic Coupling. Designed and built by the Joy Manufacturing Company, the Coupling-equipped belt conveyor system was recently installed in the Midvale, Ohio, mine of the Columbia Division, Pittsburgh Plate Glass Company.

The Twin Disc Hydraulic Coupling, with no metal-to-metal contact between the power source and the conveyor, cushions the jolting caused by intermittent loading and starts and stops . . . eliminates the greatest threat to conveyor belts and drive mechanism. As in most Hydraulic Coupling installations, a general purpose motor, rated for the running horsepower requirements of the conveyor operation, is utilized. Due to the slip characteristics of the Twin Disc Coupling, over-motoring for starting purposes is unnecessary.

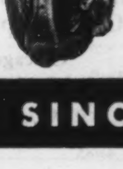
For complete information on how these Twin Disc Hydraulic Units can be applied to your power transmission problem, write the Hydraulic Division for Bulletin 136. Twin Disc Clutch Company, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Power Take-off

Heavy Duty Clutch

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

Machine Tool Clutch



Tractor Clutch

Marine Gear

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

Plymetl

The material that's making news today

For over twenty-five years, Plymetl — a Haskelite material — has helped designers and engineers build greater performance, durability and sales appeal into their manufactured products. Its use eliminates deadweight, and makes complicated framing members and fastenings unnecessary. There is only one Plymetl . . . Haskelite Plymetl . . . with its performance proved. A material of many advantages, Haskelite Plymetl is easily worked with simple metalworking or woodworking tools. It can often save man-hours to a point where the final cost of the product may be noticeably reduced. The unique strength and weight characteristics of Plymetl are graphically described in the chart below. Write for complete data and samples of Plymetl.

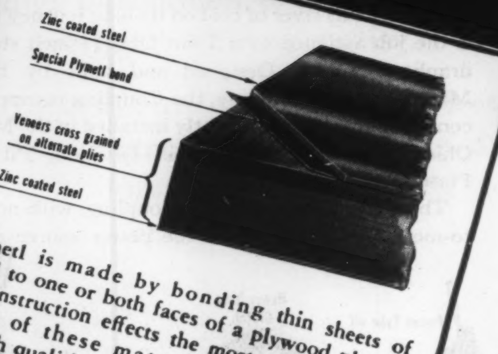
	PLYMETL UVU			**STEEL** U.S. STD. GAUGES			**ALUMINUM** B & S STD. GAUGES		
	1/4"	5/16"	3/8"	20 ga.	16 ga.	12 ga.	10 ga.	8 ga.	6 ga.
Weight in lbs. per sq. ft.	1.01	1.17	1.43	1.5	2.5	4.37	1.44	1.81	2.28
Stiffness factor E I in. ^{2} lbs.	4,900	8,400	13,200	124	575	3,050	872	1,760	3,500

	PLYMETL EVE			**STEEL** U.S. STD. GAUGES			**ALUMINUM** B & S STD. GAUGES		
	1/4"	5/16"	3/8"	20 ga.	16 ga.	12 ga.	10 ga.	8 ga.	6 ga.
Weight in lbs. per sq. ft.	2.25	2.40	2.56	1.5	2.5	4.37	1.44	1.81	2.28
Stiffness factor E I in. ^{2} lbs.	17,000	28,000	43,000	124	575	3,050	872	1,760	3,500

[illegible] that a 5/16" EVE Plymetl [illegible] steel two sides) weighs 2.40 lbs. per square foot. This is less than the weight of 16-gauge steel. However, the resistance to bending of the Plymetl panel is about 50 times as great!

Where rigidity is of prime importance consider the following: A ⅜" UVU Plymetl panel (aluminum two sides) weighs 1.43 lbs. per square foot. The weight of 20-gauge steel is 1.5 lbs. per square foot. The Plymetl panel, though lighter in weight has 106 times the stiffness of the sheet steel.

In computing the values of Plymetl, the following is assumed: (1) The modulus of elasticity of steel, 30,000,000 lbs. per sq. in. (2) The modulus of elasticity of aluminum, 10,000,000 lbs. per sq. in. (3) The modulus of elasticity for the core material, 1,300,000 lbs. per sq. in. along the grain. 65,000 lbs. per sq. in. across the grain. (4) The thickness of steel and aluminum, .021" (27 ga.) and .015", respectively. (5) The weight of plywood plaque, 30 lbs. per cu. ft.



Plymetl is made by bonding thin sheets of metal to one or both faces of a plywood plaque. Its construction effects the most efficient distribution of these materials, combining high strength qualities of the metal surfaces with low density of woods. Result: Plymetl makes an ideal structural material, simulating an I beam with the metal surfaces taking the part of the flanges and the light weight plaque acting as the web.

Write for complete data and samples.

HASKELITE

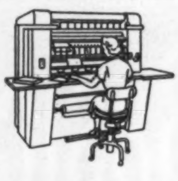
MANUFACTURING CORPORATION

Dept. D. Grand Rapids 2, Mich.

New York Chicago Detroit
St. Louis Philadelphia Los Angeles
Canada: Railway & Power Engineering Corp., Ltd.

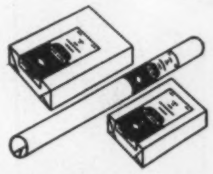
Everything for the engineer and draftsman

BRUNING:
one convenient source
one high quality



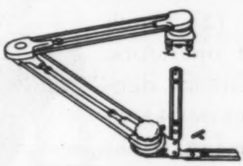
Bruning Whiteprinters

Make crisp, sharp whiteprints within seconds from your translucent drawings or documents with any Bruning Whiteprinter. Choose from many fine machines for the model with a capacity that perfectly fits your need.



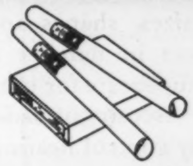
BW Paper, Film & Cloth

A wide variety of paper sizes to select from—both in flat sheets and in roll stock. Light, medium, and card weights. White or tinted papers. Sensitized transparent paper, film, and cloth are always available from Bruning, too.



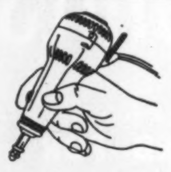
Bruning Drafters

Actual tests prove they save up to 40% of the draftsman's time. Fewer motions are needed: these machines combine T-square, scales, straightedge, triangle, and protractor into one precision instrument. Six models available.



Tracing Papers & Cloths

Every type of tracing medium required in the modern drafting or engineering department is available from Bruning. These products have proved their serviceability over many years in making better tracings and prints.

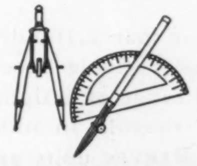


Bruning Erasing Machines

This new machine saves valuable time erasing pencil, ink, typing, carbon copy, and other marks. A 7-inch eraser is housed in motor shaft. Quiet, vibration-free and cool. An efficient tool for all departments within your firm.

Drafting Room Furniture

Bruning provides a complete line of drawing tables, drawing boards, filing cabinets, stools, etc. The functional design of each provides for easy, efficient use. Strongly built to give a long life of hard and steady service.



Bruning Drawing Instruments

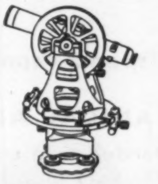
A large variety of ruling pens, beam compasses, bow instruments, and industrial drafting sets are available from Bruning. Drafting tools such as protractors, curves, triangles, T-squares, pantographs etc., are also featured.

Bruning Drawing Materials

If it is a drawing material used in a drafting or engineering design department—Bruning has it . . . and you can be sure that it is right in every detail. You can rely on the name "Bruning" for uniformly high quality.

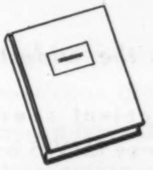
Bruning Slide Rules

Bruning Slide Rules are precision tools. They are graduated to exacting tolerances, with precise graduations that do not lose their excellent visibility. Construction throughout is to typical high Bruning standards of quality.



Surveying Instruments

Bruning carries a large and complete line of transits, levels, barometers, compasses, leveling rods, steel tape, stop watches, tripods, etc. Competent Bruning instrument men repair any make of surveying instrument.



Technical Books

Bruning makes available many excellent handbooks on civil, mechanical, structural, and electrical engineering; highway and railway design; architecture, concrete, drawing, lettering, and similar important subjects.

It pays you to concentrate your buying

Order all your engineering and drafting supplies thru Bruning. 14 Bruning branches and many authorized Bruning Dealers are located conveniently thru the U.S. They give you prompt, efficient, and courteous service that makes ordering easy.

Send today for details. Ask us for full information on any or all of the above Bruning products. If what you want is not listed, ask us about it. Chances are, if it's used by an engineer or a draftsman, we have it. Clip the coupon.

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Memo--to machine designers

3 Basic Reeves Units

MEET EVERY NEED FOR ACCURATE SPEED CONTROL

No matter what type of machines you design or build, the answer to your speed control problem can be found in one or more of the three basic REEVES units—Variable Speed Transmission, Motodrive or Vari-Speed Motor Pulley—shown at right.

Providing instant, accurate, infinite speed adjustability, REEVES Speed Control can be adapted to your new designs to perform any of these essential, money and time-saving functions: (1) handle more sizes, shapes and materials, (2) match variances in number and skill of operators, (3) compensate for change in consistency, density or viscosity of materials in process, (4) accurately control heating, baking, drying, cooking or chilling time, (5) maintain uniform peripheral speed or tension on decreasing or increasing diameters, (6) maintain uniform pressure, weight, liquid level, temperature and other variable elements, (7) regulate conveyor speeds, even to fractions of an inch per minute, and (8) synchronize all working parts of one machine or machines operating in a series.

Now standard equipment on more than 2,100 different makes of machines, REEVES Variable Speed Control units are offered in a wide range of designs, sizes, capacities, speed ratios and controls. In addition, internal operating parts of REEVES units are available for easy incorporation within the framework of your machines.

A widely experienced REEVES Speed Control specialist will be glad to discuss your particular problems of application. Meanwhile, for complete information on the entire REEVES line, write for the new 114-page catalog, H15-450A.

REEVES offers the widest selection of speed-changing controls

MANUAL (HANDWHEEL)—Convenient speed-changing handwheel is standard on all three REEVES basic units. Extended shifting equipment is available whenever required, such as on ceiling installations.

HYDRAULIC AUTOMATIC—Applied to either Transmission or Motodrive, this completely automatic control makes it possible to synchronize different machines and separate sections of a single machine. It is especially suitable for operations requiring split-second speed changes; responsive to operating force of only one or two ounces.

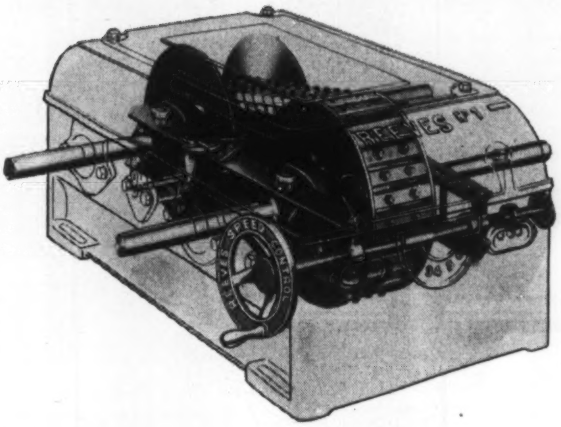
MECHANICAL AUTOMATIC—Speed-changing levers are extended to a cross-head joining the toggle mechanism into frame of Transmission or Motodrive. From this cross-head a lever is extended and connected to any element from which indication of required speed can be taken. Thus, lateral movement of extended lever regulates speed of machine.

ELECTRIC REMOTE—With electric remote control applied to any one of the three REEVES units, speeds may be changed by one or more push-button stations located at any distance from the unit.

REEVES PULLEY COMPANY · COLUMBUS, INDIANA

Recognized Leader in the Specialized Field of Speed Control Engineering

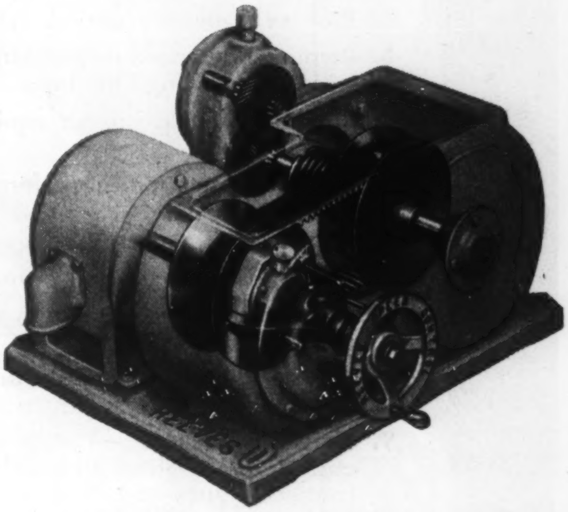
TRANSMISSION



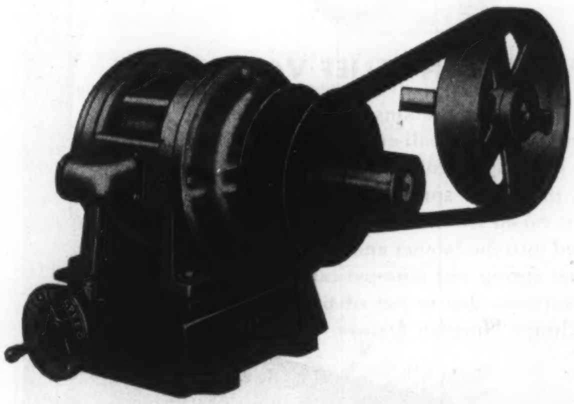
The REEVES Variable Speed Transmission is the original compact and mechanically correct unit which provides adjustable speed control for industrial machines. Design is based on the time-tested principle of a V-belt driving between two pairs of adjustable cone-faced discs mounted on parallel shafts. One shaft receives power at constant speed from motor, line-shaft, etc. The other, connected to driven machine, transmits power at infinitely adjustable speeds above and below speed of constant speed shaft as V-belt assumes different diameters of contacts against each set of discs. Any speed setting is held without fluctuation because ***belt tension is positively maintained at all driving diameters.*** Sizes: fractional to 87 hp. Speed ratios: 2:1 through 16:1. Both vertical and horizontal designs—open or enclosed types—are available.

MOTODRIVE

The REEVES Motodrive combines a constant speed driving motor, variable speed control mechanism and speed reducing gears (where required) in one self-contained unit. It is designed for use on production machines of all types and is particularly well adapted to installations where space is limited or where direct connection to the machine is desired. Any make of foot-type, ball-bearing constant speed motor in standard NEMA dimensions may be used. Built in both horizontal and vertical designs the Motodrive is simple, rugged and easily serviced. Transmission of power is accurate at all speeds. The Motodrive is available in six sizes, covering capacities from ¼ to 15 hp and in speed ratios from 2:1 through 6:1. Helical reduction gears in ratios up to 189:1 may be incorporated in the Motodrive to provide the desired output speeds.



MOTOR PULLEY



The REEVES Vari-Speed Motor Pulley is a simplified development of the REEVES Transmission designed especially for requirements of light horsepower and limited speed range and for application directly to the shaft extension of any standard constant speed motor. The unit forms the actual driving element between the motor and the driven shaft, eliminating all auxiliary equipment such as chain drives, gears, belts, etc. It requires practically no more space for installation than any standard belt or chain drive, and its compactness appeals to machine designers who wish to incorporate speed control as standard equipment. The Vari-Speed Motor Pulley is built in eleven sizes, transmitting from ⅛ to 15 hp and providing infinite speed adjustability over ratios of speed variation from 2¼:1 to 4:1 inclusive.

Accurate Variable

REEVES Speed Control

Gives the Right Speed for Every Job!

ew

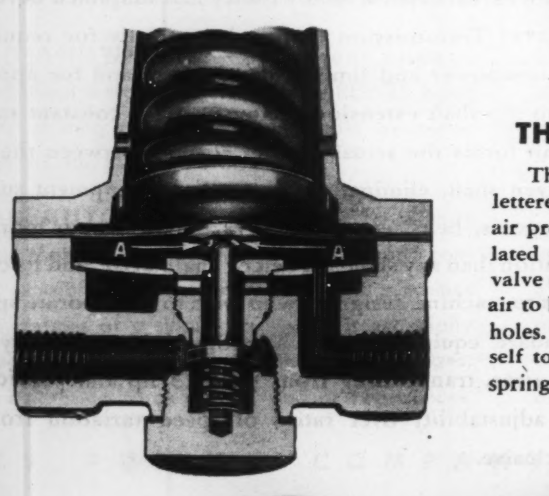
Norgren Reli

Regulator

holds pressure without "creep"

1. Performance exceeds that of many larger, more expensive relieving type regulators having larger diaphragms and valve ports.
2. Positive protection against "creep."
3. Permits downward adjustment of pressure without "bleeding" the line.
4. Eliminates damage to air equipment due to pressure surges.
5. Improves air equipment performance. Reduces wear and repairs.
6. Baffle plate and Syphon Tube permit *greater air flow with less pressure drop.*
7. Responds faster to changes in secondary pressure.
8. Prevents faulty performance due to out-of-line regulating springs.
9. Simple maintenance.—Can be easily and quickly disassembled without removing from the line—requiring only screwdriver and crescent wrench.

Norgren
C.A. NORGREN CO



THE NEW BUILT-IN RELIEF VALVE

The lower spring rest contains the valve opening lettered "A" and rests on a ball-end valve pin. When air pressure in the diaphragm area exceeds the regulated pressure, the lower spring rest containing the valve opening is raised from the valve pin permitting air to be released into the bonnet and out the breather holes. The lower spring rest automatically adjusts itself to any eccentricity due to out of line regulating spring—an exclusive Norgren feature.

A nickel-in-the-slot... or 1000 p.s.i. on the line

AMERICAN FLEXIBLE METAL CONNECTORS HANDLE BOTH PROBLEMS

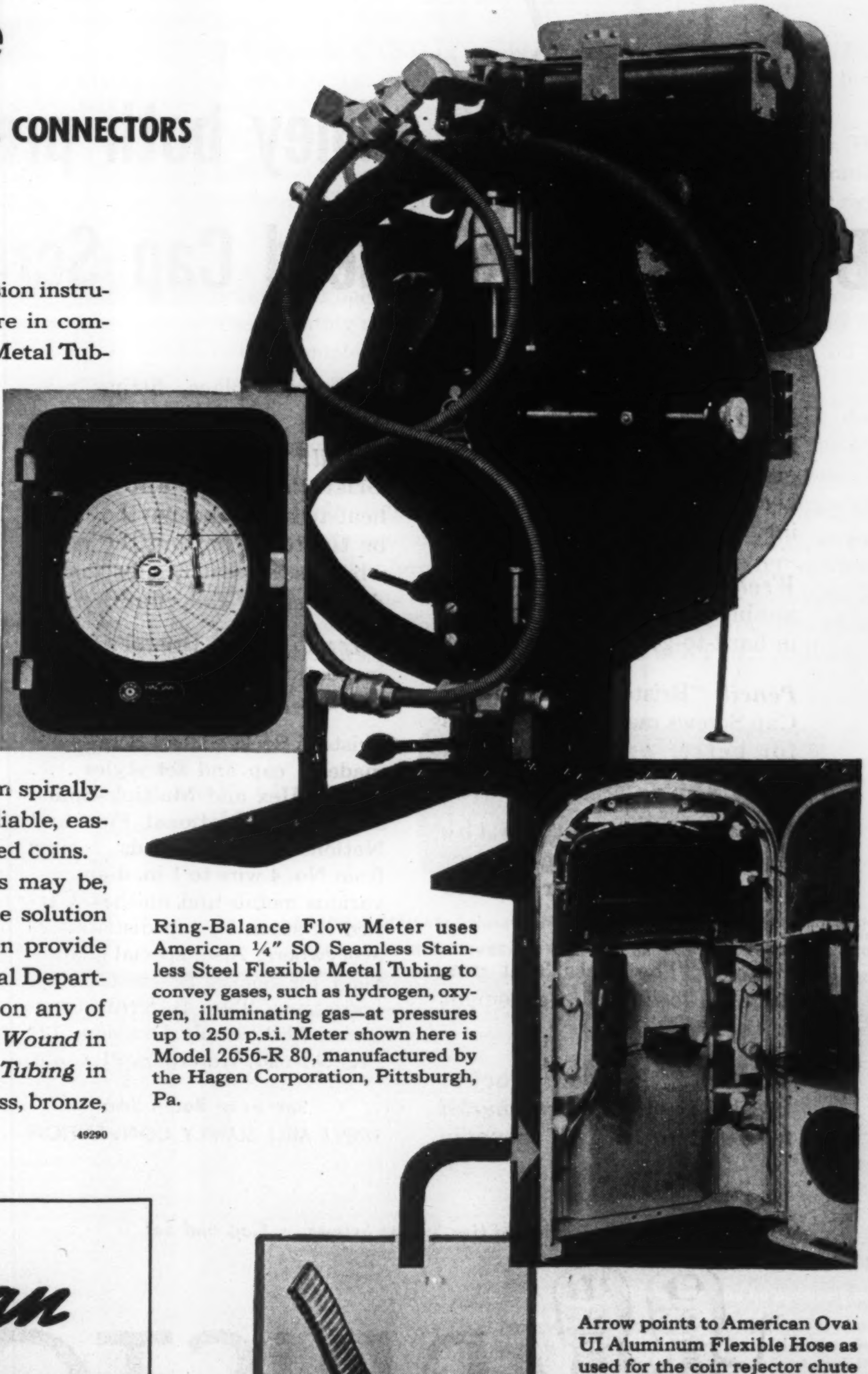
These two radically different precision instruments have one noteworthy feature in common: both use American Flexible Metal Tubing, different types of course, but each "tailored" by us to do its job exactly right.

In the Hagan Ring-Balance Flow Meter two lengths of stainless steel seamless flexible metal tubing connect the meter with the gas lines. This rugged, precise connector is made from one-piece seamless tubing, corrugated for maximum flexibility.

In the Rock-Ola Coin-operated phonograph flexible metal hose, oval in cross-section and made from spirally-wound aluminum strip, forms a reliable, easily-installed return chute for rejected coins.

Interesting as these applications may be, you will be more satisfied with the solution American Flexible Metal Hose can provide for your own problem. Our Technical Department is available for consultation on any of our flexible metal hose types: *Strip Wound* in I.D.'s through 12" and *Seamless Tubing* in I.D.'s through 4"—both types in brass, bronze, stainless steel, nickel, etc.

49290



Ring-Balance Flow Meter uses American 1/4" SO Seamless Stainless Steel Flexible Metal Tubing to convey gases, such as hydrogen, oxygen, illuminating gas—at pressures up to 250 p.s.i. Meter shown here is Model 2656-R 80, manufactured by the Hagen Corporation, Pittsburgh, Pa.

Arrow points to American Oval UI Aluminum Flexible Hose as used for the coin rejector chute on coin-operated phonographs made by the Rock-Ola Manufacturing Co., Chicago, Ill. Construction of this hose is shown at left.

ANACONDA
from mine to consumer

American

METAL HOSE

THE AMERICAN BRASS COMPANY

American Metal Hose Branch

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
Distributed in Canada by:
THE CANADIAN FAIRBANKS-MORSE COMPANY LIMITED

They both prefer Bristol's Socket Head Cap Screws

Pencil: "With Bristol's Socket Head Cap Screws, designs can be more *compact*—small pockets, narrower flanges, etc.—because of the internal wrenching."

Wrench: "It's easier for the assembly man, too—particularly in hard-to-get-at places."

Pencil: "Bristol's Socket Head Cap Screws mean *flush* surfaces for better appearance and safety."

Wrench: "They take the wrench without fumbling or slippage—no danger of skid marks on the work."

Pencil: "The Class 3 fit produces a *lock-tight* engagement in the hole."

Wrench: "Bristol's Socket Head Cap Screws are *knurled* for easier starting, and they spin easily into place, fitting perfectly."

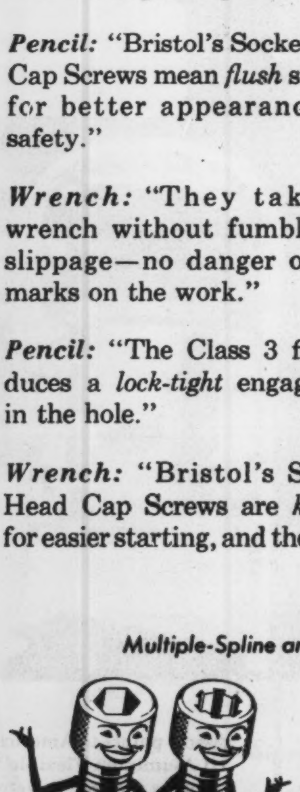
Pencil: "The great strength of Bristol's special alloy steel, heat-treated, means they can be tightened beyond the point where screws normally loosen due to shock and vibration."

Wrench: "And Bristol's 5-step inspection means that every one is a *perfect* fastener."

Bristol's Socket Head Screws are made in cap and set styles . . . regular Hex and Multiple-Spline socket . . . National Fine and National Coarse Threads . . . sizes from No. 4 wire to 1 in. diam. . . . various metals and finishes. Carried in stock by top distributors everywhere. Also, special shapes. Send for Socket Screw Catalog, addressing THE BRISTOL COMPANY, Mill Supply Division, 122 Bristol Road, Waterbury 91, Conn.

See us at Booth 866
TRIPLE MILL SUPPLY CONVENTION

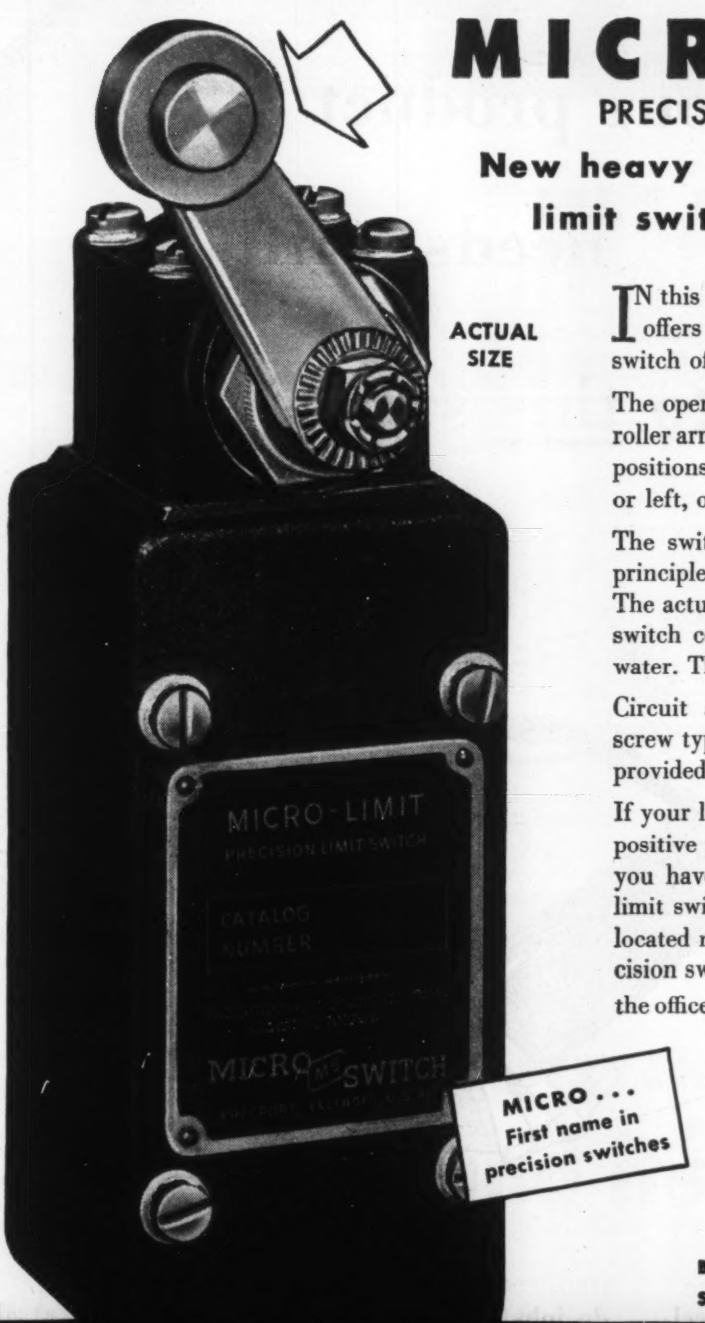
Multiple-Spline and Hex Socket Screws . . . Cap and Set



BRISTOL'S

SOCKET SCREWS

Only BRISTOL gives you the right Socket Screw for every application



MICRO-LIMIT
PRECISION LIMIT SWITCH
CATALOG NUMBER
MICRO SWITCH
FREEPORT, ILLINOIS, U.S.A.

ACTUAL SIZE

MICRO ...
First name in precision switches

MICRO-LIMIT...

PRECISION LIMIT SWITCH

New heavy duty, general purpose precision limit switch for *Severe Industrial Service!*

IN this new MICRO-LIMIT heavy duty switch, MICRO SWITCH offers design engineers a precise, ruggedly constructed limit switch of almost unbelievable versatility.

The operating head can be mounted in any of four positions. The roller arm is adjustable through 360° to 870 positive-lock operating positions. The switch is field-adjustable to operate to either right or left, or in both directions, with ample overtravel.

The switching element, with the MICRO SWITCH snap-action principle of operation, is securely sealed within a die cast housing. The actuating mechanism operates through a seal which gives the switch complete protection against dirt, dust or splash of oil or water. The switching element is easily replaceable.

Circuit arrangement is single-pole, double-throw; heavy duty screw type terminals are easily accessible. Ample wiring space is provided. Standard ½″ conduit outlet is provided in the base.

If your limit control requirements call for the utmost in long life, positive performance, rugged construction and versatility, be sure you have full information on the new MICRO-LIMIT precision limit switch. Experienced MICRO SWITCH sales engineers are located near you. For any problem that involves the use of precision switches...where ordinary switches won't do... call any of the offices listed.

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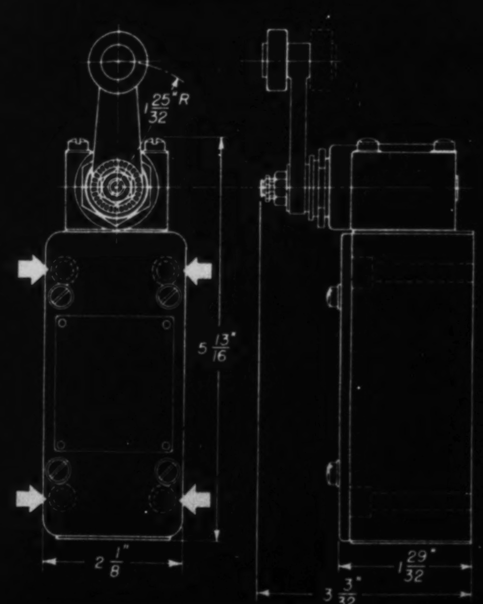
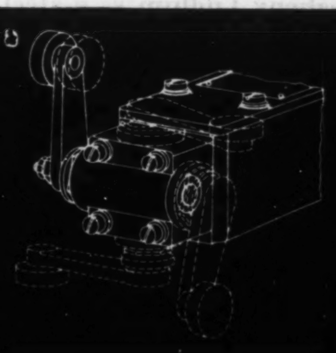
MICRO SWITCH
FREEPORT, ILLINOIS, U.S.A.

BRANCH OFFICES: Chicago • New York • Boston • Cleveland • Los Angeles
SALES REPRESENTATIVES: Portland • St. Louis • Dallas • Toronto

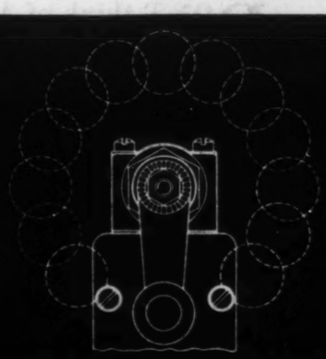


25/32″ R
5 13/16″
2 1/8″
1 29/32″
3 3/32″

Four blind mounting holes for ¼″ screws (shown by arrows) are provided in case—accessible with cover plate removed.

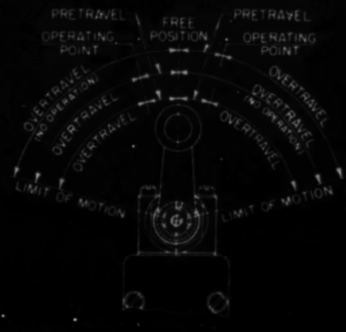


Operating head mounts in any of four positions shown. In addition, roller arm may be reversed as indicated.



Roller arm may be positively locked in any of 870 different positions at intervals of approximately 0.4°.

Operating shaft may be positioned for any one of the conditions of operation shown at right.



PRETRAVEL
OPERATING POINT
FREE POSITION
PRETRAVEL
OPERATING POINT
OVERTRAVEL (NO OPERATION)
OVERTRAVEL
OVERTRAVEL
OVERTRAVEL
OVERTRAVEL (NO OPERATION)
OVERTRAVEL
LIMIT OF MOTION
LIMIT OF MOTION

When your product needs a lift

Hitch on to this star!

DON'T think of Allegheny Ludlum as a steel producer in the ordinary sense. We don't make "ordinary" steels.

Our job is to create and develop materials in the special alloy field: stainless and heat-resistant steels, tool and die steels, carbide metals, special electrical and magnetic materials, and super-alloy steels for high temperature service. The function of these products is either to do existing jobs better than ordinary steels or other materials can do them; or to reach out into new fields and do jobs that previously couldn't be done at all. In practically every case, the use of these special alloy steels proves not only to be economically sound, but actually cheapest in the long run.

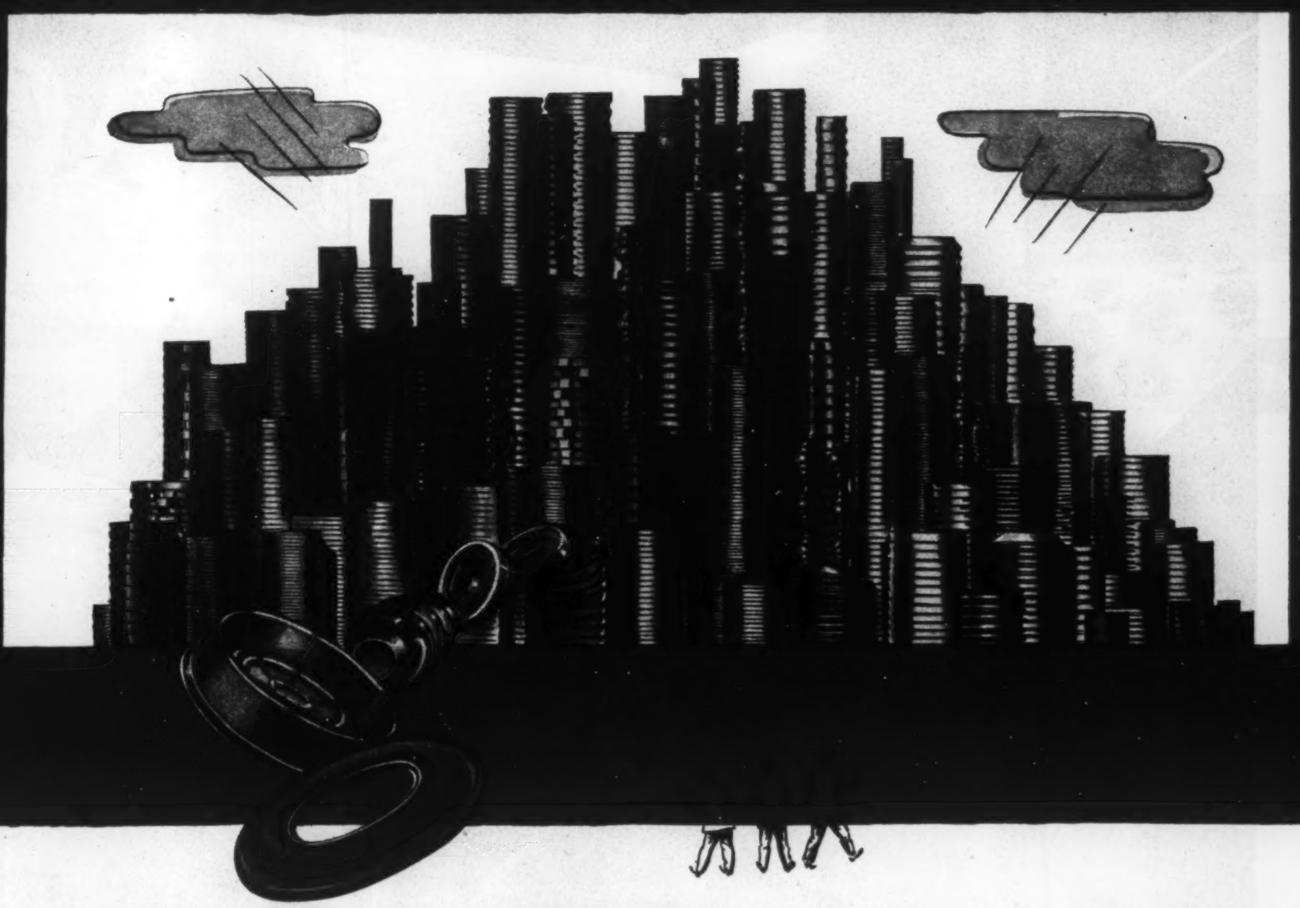
Do you want to *add* something to present products: longer life, more wear, better looks, greater strength, less weight, finer performance? *Let us help you do it.* Do you have a new device, or re-design, still in the "good idea, but haven't found the right material" stage? *Call us in—that's our job!*

Complete technical and fabricating data—engineering help, too—yours for the asking. W&D 2350

ALLEGHENY LUDLUM STEEL CORPORATION

The Nation's Leading Producer of Stainless Steel in All Forms

Pittsburgh, Pa. . . . Offices in Principal Cities
Allegheny Metal is stocked by all Jos. T. Ryerson & Son, Inc., Warehouses



A MOUNTAIN OF SIRVENE

and it's all earmarked

Chances are the Sirvene part you order will be utterly unlike any other. For, while Chicago Rawhide produces literally tons of Sirvene in a year's time, every batch is earmarked for a different pliable part. Each of these parts is designed and developed to do just one special job in a particular mechanism. For every application, Sirvene engineers compound a special formula from pure, oil-resistant elastomers. From it, they mold a custom-engineered part which will fulfill specific requirements in tensile strength, elongation, elasticity or hardness, resilience, and resistance to dryness, moisture, temperature extremes and other deteriorating elements. As a result of laboratory-controlled production methods, Sirvene parts function under unusually severe conditions. That's why engineers across the country depend on Sirvene for their critical pliable parts. Sirvene engineers offer you their unlimited backlog of experience and research. Use it in solving your mechanical elastomer problems.

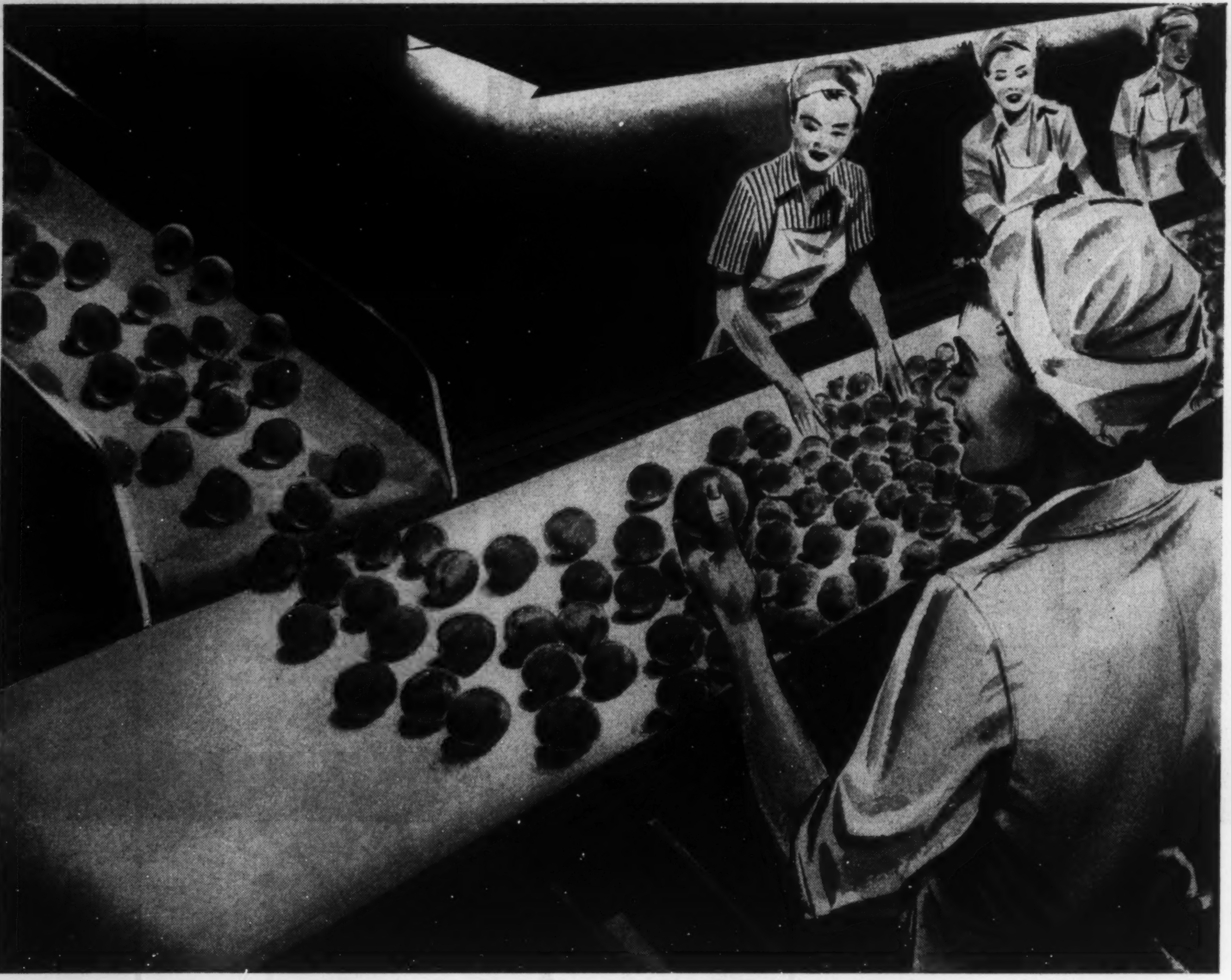
CHICAGO RAWHIDE MANUFACTURING CO.
1304 Elston Avenue **SIRVENE DIVISION** Chicago 22, Illinois

Sirvene products include diaphragms, boots, gaskets, oil seals, washers, packings, and other special molded mechanical pliables

OTHER
C/R PRODUCTS
PERFECT
OIL SEALS
Sirvis
MECHANICAL
LEATHER

ENGINEERS: For basic information, write for your copy of "Engineering with Sirvene." There is no charge.

SIRVENE
THE SCIENTIFIC COMPOUNDED ELASTOMER



NOW THEY DON'T LOSE THEIR "PEACHES-and-CREAM" COMPLEXION

An example for you of the cushioning power of SPONGEX Sponge Rubber

Only the best peaches get to market today. On this moving belt those not up to grade are picked out by experienced workers. But—peaches bruise easily. One processor found he was losing money because fruit rolling from hoppers onto ordinary belts was frequently damaged by the impact.

When called in on the problem, our engineers recommended surfacing the conveyor belt with soft, resilient *Spongex* sheet sponge rubber. This *Spongex* not only cushions the fruit as it falls from hoppers, eliminating bruising, it outlasts the canvas belt to which it is bonded.

Solving special problems of cushioning, sealing, insulating, sound-deadening and vibration reduction is an everyday job for *Spongex.* And *Spongex* does a better job because it's made by a company that has specialized in cellular rubber products for over 25 years.

Spongex today is used in an almost infinite number of products . . . from all kinds of molded seals and gaskets, motor suspension pads, seat cushions and backs, to weatherstripping, and rubber parts in a thousand different shapes and forms. Its resiliency, uniform cell structure, tensile strength and resistance to temperature extremes, moisture, acids, abrasion and aging make it a material worth your serious consideration. Write today, naming your product and problem. Sponge Rubber Products Co., 122 Derby Place, Shelton, Conn. Sales offices in principal industrial centers.

see our CATALOG in SWEET'S FILE

Trade Marks Reg. U. S. Pat. Off.

SRp

SPONGE RUBBER PRODUCTS CO.

SPONGEX • CELL-TITE • TEXFOAM • TEXLITE • TEXLOCK

Wichita City Library

NEW

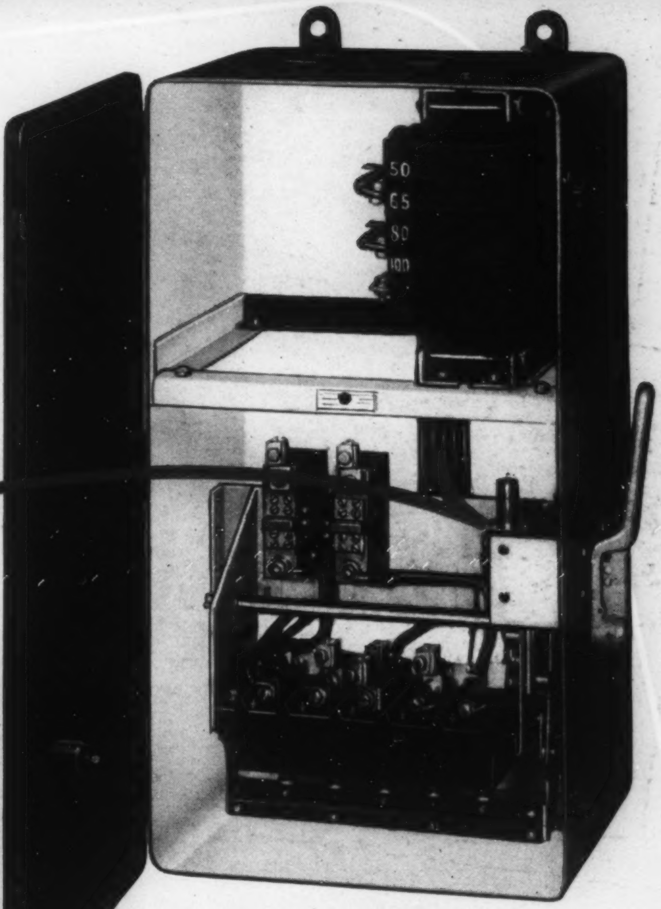
Bulletin 646

Manual Transformer-Type Reduced-Voltage Starter

Here is the first outstanding improvement in manual transformer-type starters in twenty-five years. It is a worthy addition to the Allen-Bradley line of motor controls.

An unusual feature is its adjustable time delay, which prevents careless operators from switching the motor too quickly to full running voltage. Many other features are described on the next page.

with time
delay switchover



SIZE B—50hp, 220v; 100hp, 440-600v

The NEW Bulletin 646 Manual Transformer-Type Starter differs in many details from older types of reduced-voltage starters.

Time-tested developments . . . like Allen-Bradley double break, silver alloy contacts . . . assure long, trouble-free service. See next page for further details.

Allen-Bradley Co., 1316 S. Second Street, Milwaukee 4, Wis.

ALLEN-BRADLEY

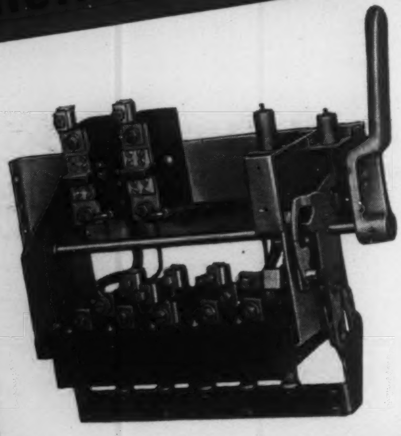
BULLETIN 646 TRANSFORMER-TYPE STARTER

QUALITY

TURN
see next page

EXCEPTIONAL FEATURES *of the*

Bulletin 646 Manual Transformer-Type Starter



TIME DELAY SWITCHOVER

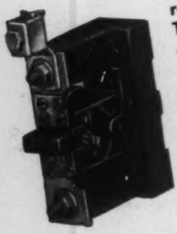
The Bulletin 646 switching mechanism is a simple, mechanical linkage operated by a two-position, manual starting lever. When the lever is pulled forward, the switch mechanism moves the contacts into the "Start" position. This permits the motor to accelerate at reduced voltage.

An interlock, under dashpot control, prevents the starting lever from being thrown into the "Run" position until the motor has accelerated for several seconds. This timing is adjustable to suit varied starting conditions.

No-voltage protection is also provided by a magnetically operated hold-in latch. Man, motor, and machine are fully protected against accidents and damage from line failures.

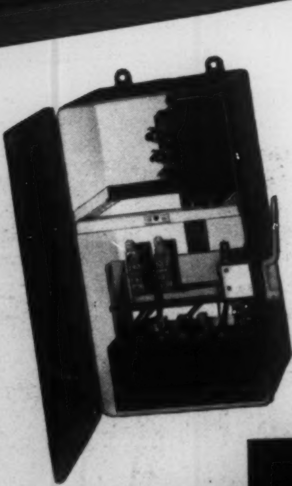
DEPENDABLE OVERLOAD RELAYS

The accurate, reliable overload relays operate on the soldered ratchet principle. They remain reliable in operation, even after long inactivity. Thermal elements available for any load. Contacts are pure silver.



DOUBLE BREAK, SILVER ALLOY CONTACTS

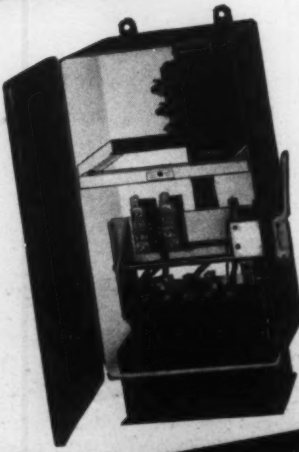
Starting and running contacts are mounted in a molded contact block. Double break, movable contacts are attached to copper spanners, spring-mounted on an insulated rocker arm. In the starting position, the movable contacts bridge the motor and reduced voltage contacts. In the running position, they bridge the motor and line voltage contacts. Easily accessible for inspection.



CAN BE SUPPLIED WITH OIL-IMMERSED CONTACTS

For installations requiring oil-immersed contacts, Bulletin 646 Transformer-Type Starters can be supplied with an oil tank, inserted through the bottom of the enclosure. The tank is suspended on threaded studs, which serve as hangers when the tank is lowered. Since contacts immersed in oil deteriorate much more rapidly than when operated in air, air-break starters are preferable for most applications.

Allen-Bradley Co., 1316 S. Second St.
Milwaukee 4, Wis.



TURN

see
front
page

Send for
Bulletin 646

ALLEN-BRADLEY

Reduced-Voltage Starters for Squirrel-Cage Motors

QUALITY

TOUGH!

—high fatigue strength, high tensile strength, withstands extremely high working loads

HARD!

—can be oil quenched to a maximum hardness of 64/66-Rockwell C in moderate sections.

EASY TO MACHINE!

—has fully spheroidized structure.

IDEAL FOR PARTS LIKE THESE:

1. Diesel injection pumps
2. slitting rolls and knives
3. machine tool parts
4. mill rolls
5. mechanical seals
6. cam rollers for automotive steering gears
7. lathe centers
8. pump parts
9. saw mill rollers
10. asbestos disintegrators
11. anti-friction bearings
12. aircraft engine parts

—that's TIMKEN® 52100 steel!

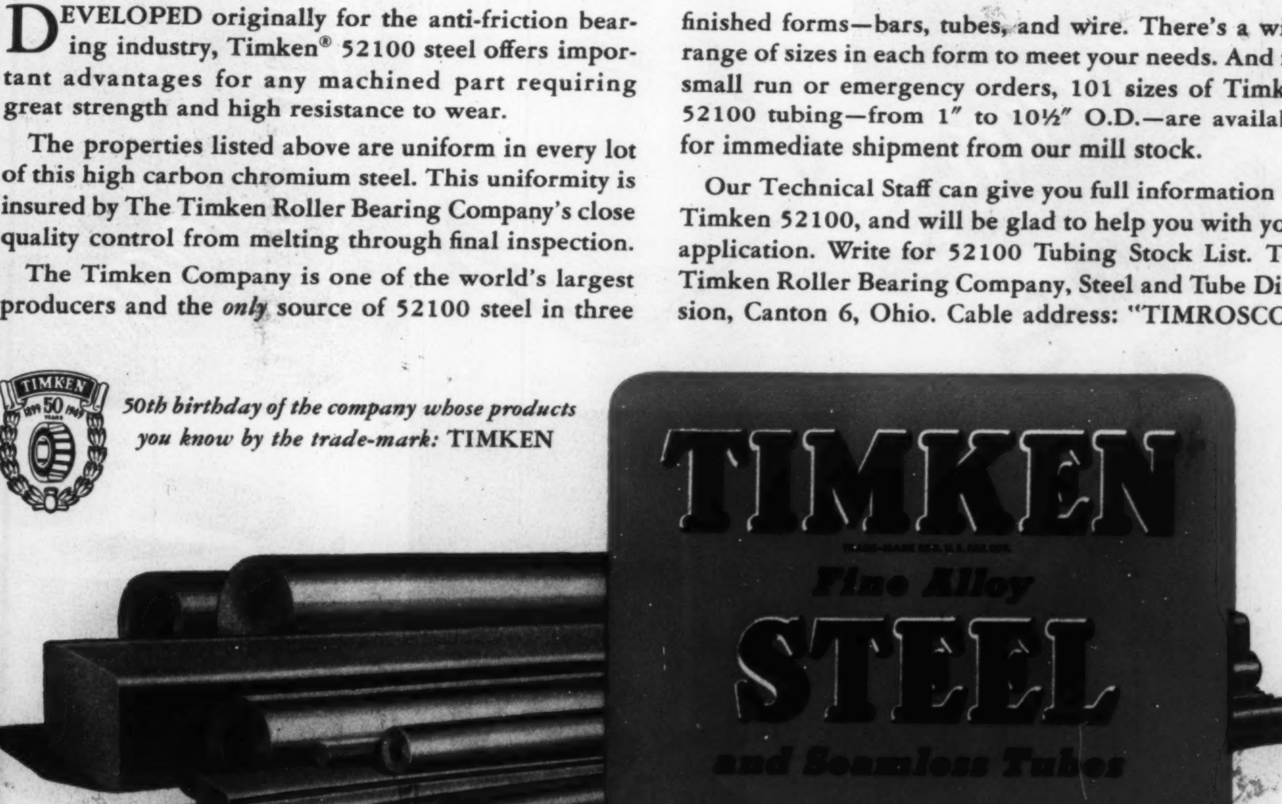
DEVELOPED originally for the anti-friction bearing industry, Timken® 52100 steel offers important advantages for any machined part requiring great strength and high resistance to wear.

The properties listed above are uniform in every lot of this high carbon chromium steel. This uniformity is insured by The Timken Roller Bearing Company's close quality control from melting through final inspection.

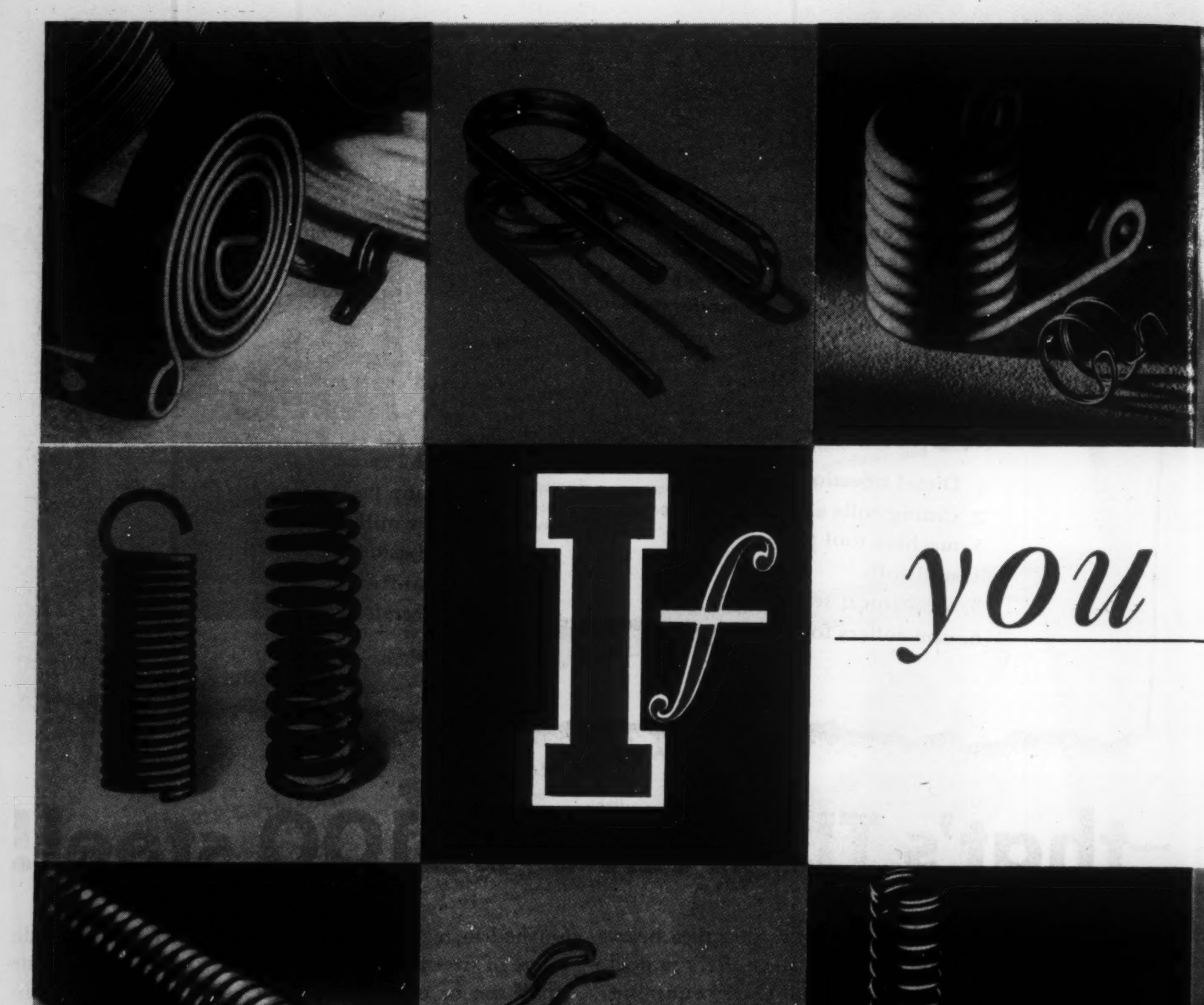
The Timken Company is one of the world's largest producers and the *only* source of 52100 steel in three finished forms—bars, tubes, and wire. There's a wide range of sizes in each form to meet your needs. And for small run or emergency orders, 101 sizes of Timken 52100 tubing—from 1″ to 10½″ O.D.—are available for immediate shipment from our mill stock.

Our Technical Staff can give you full information on Timken 52100, and will be glad to help you with your application. Write for 52100 Tubing Stock List. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

50th birthday of the company whose products you know by the trade-mark: TIMKEN



Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.


If you

use springs

...then this is for you!

● There is only one place where spring performance can be judged accurately. In service! That's where your choice of spring material spells the difference between bristly tempers and customer satisfaction.

While we can't advise you on the way to handle the *complaints* about spring failures, we believe we can give you some sound advice on how to *minimize* failures. And that is—*install American Quality Springs.*

In automobiles . . . farm equipment . . . alarm clocks . . . phonographs . . . typewriters . . . window shades and hundreds of other products, American Quality Springs have done an outstanding job. They have withstood extreme temperature changes. They've given years of faithful service under high stresses. They've been subjected to severe corrosive conditions and have come through with flying colors. And they've given admirable performance in applications where exceptionally close tolerance precision and unfailing uniformity were imperative.

In helping you work out your spring problem we offer the services of highly-trained spring engineers who keep in touch intimately with the latest metallurgical developments. And we place at your disposal production and testing facilities that are generally regarded as the finest in the country. Contact our nearest office or 408 Rockefeller Building, Cleveland 13, Ohio.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM, SOUTHERN DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

AMERICAN QUALITY SPRINGS

UNITED STATES STEEL

Steel-Weld

FABRICATION

In these Steel-Weld Fabricated combined engine beds and crankcases, and cylinder blocks for marine diesels, is further evidence of the type of workmanship you can expect from Mahon craftsmen. No matter what your requirements may be, regardless of size or weight, the Mahon Company is prepared to turn out smoother, finer appearing Steel-Weld Fabricated parts and assemblies to your specifications. Complete machining facilities, capable of handling heavy, cumbersome pieces of unusual dimensions, are available for either rough or finished machine work. These facilities, plus the long experience of Mahon Steel-Weld design engineering experts, assure you every advantage of Steel-Weld Fabrication.

THE R. C. MAHON COMPANY
Detroit 11, Michigan

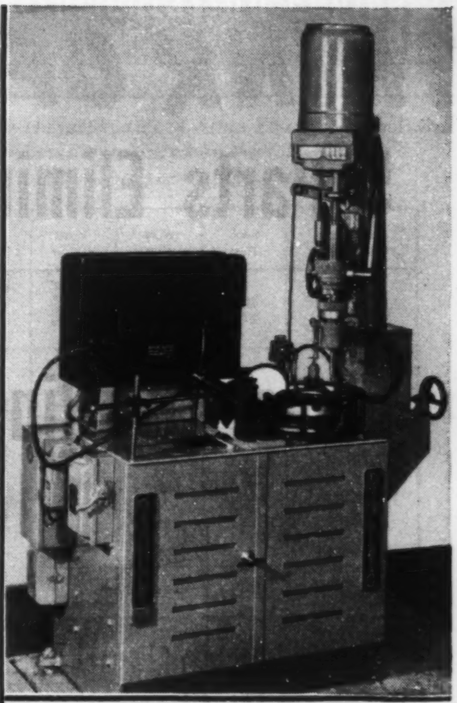
Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

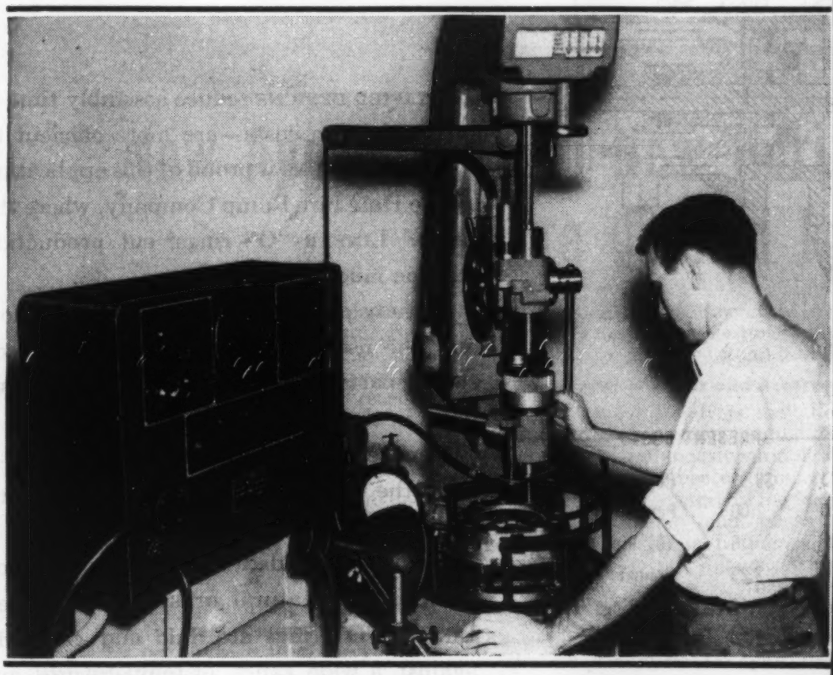
MAHON

MACHINE BALANCES CLUTCH ASSEMBLIES!

Phenomenal speed and accuracy are achieved with the Gisholt machine which performs all four steps in the complete balancing operation as follows: (1) locates unbalance, (2) measures unbalance, (3) corrects unbalance, (4) checks balance. Designed especially for this work, the machine handles operations at the rate of 80 pieces per hour.

Gisholt ISV Dynetric Balancer





Saves handling time

With correction drill incorporated as a part of the machine, it is unnecessary to remove work piece from mounting for drilling. Handling time is cut to a minimum.

Corrections clearly indicated

Readings clearly show where and how much metal is to be removed in units of drill depth. All chips are automatically ejected so they cannot get caught in the clutch pressure springs.

Insures better service Whether it's in production or repair work, the balancing of clutch plate assemblies is of little avail unless it is done *accurately.* And here, again, the DYNETRIC principle provides the accuracy which makes Gisholt the unquestioned leader in the field of balancing. Full information on request.

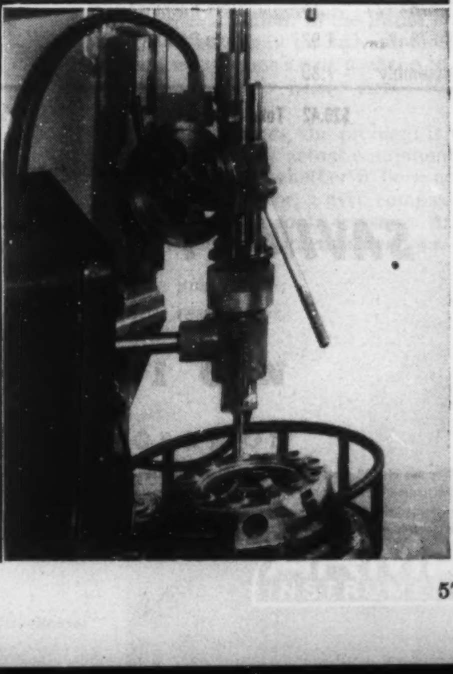
GISHOLT MACHINE COMPANY

Beautiful Madison, Wisconsin

DYNETRIC BALANCERS GISHOLT

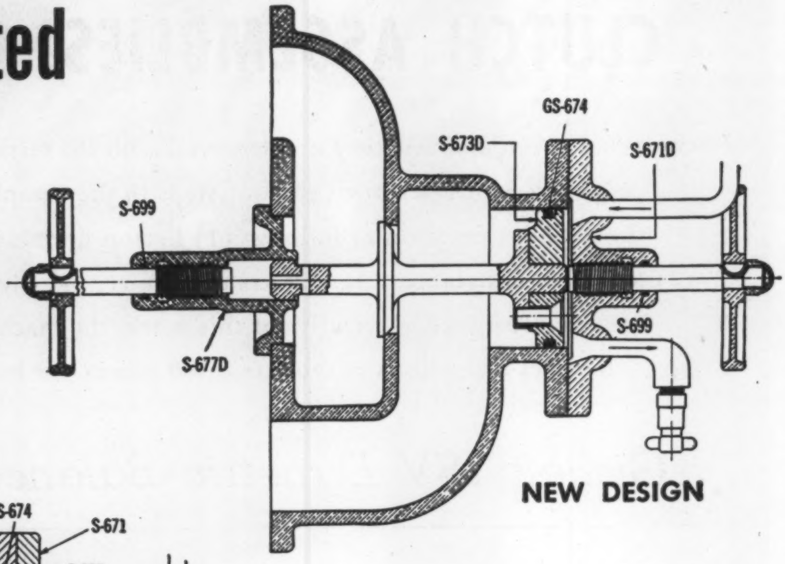
DEVELOPED JOINTLY WITH WESTINGHOUSE ELECTRIC CORPORATION
"DYNETRIC" IS A TRADE MARK REG. U. S. PAT. OFFICE BY WESTINGHOUSE ELECTRIC CORPORATION

TURRET LATHES • AUTOMATIC LATHES
BALANCERS • SUPERFINISHERS • SPECIAL MACHINES

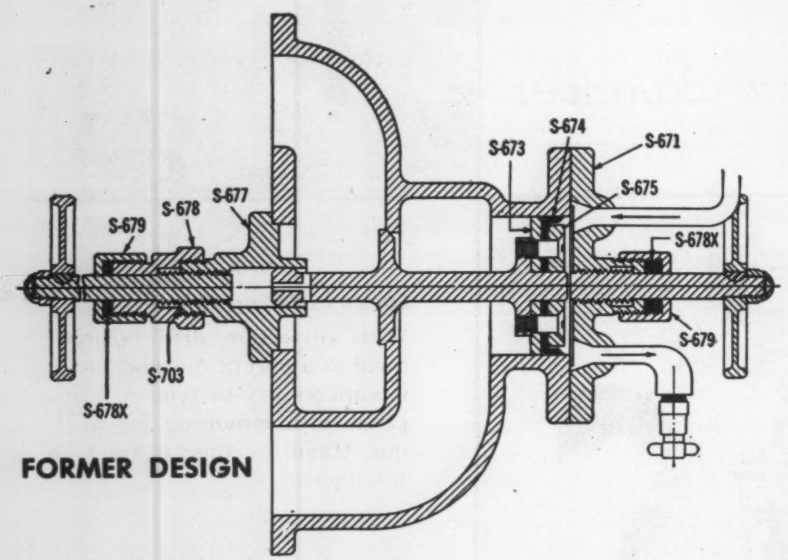


THINK OF IT...22.4% SAVING

5 Parts Eliminated with Linear "O" Rings



NEW DESIGN



FORMER DESIGN

FORMER COSTS		
S-671	$3.92	Piston Head Cover
S-673	1.05	Piston
S-674	.22	Piston Cup
S-675	1.29	Cup Retainer
S-677	2.29	Bonnet
S-678	1.77	Bonnet Nut
S-678X (2)	.15	Stem Packings
S-679 (2)	1.92	Stem Packing Nuts
Assembly	7.80	
	$20.42	Total–Former Costs

PRESENT COSTS		
S-671-D	$3.92	Piston Head Cover
S-673-D	2.00	Piston
GS-674	.16	"O" Ring
S-677-D	2.29	Bonnet
S-699 (2)	.18	"O" Rings
Assembly	7.30	
	$15.85	Total–Present Costs

(The above figures include estimated costs of all overhead.)

SAVING PER VALVE—$4.57

SIMPLIFIED DESIGNS reduce assembly time—cut production costs—are more efficient in operation. LINEAR is proud of this application by the Hale Fire Pump Company, where the use of LINEAR "O" rings* cut production costs as much as 22.4%.

A study of the two schematics will show how the use of LINEAR "O" rings replaced eleven parts in the former design with six parts in the new design.

Itemized at left are the packing costs—note the great savings effected by using LINEAR "O" rings.

Precision moulded to extremely close tolerances from natural or synthetic rubber, LINEAR "O" rings are fluid and gas tight against a wide range of temperatures and pressures.

LINEAR "O" rings are available in standard sizes from 1/8" to 15½" ID and in special sizes as required. And LINEAR engineering experience is at your disposal on *tough* problems. Send full details and copies of your blue prints.

"PERFECTLY ENGINEERED PACKINGS"

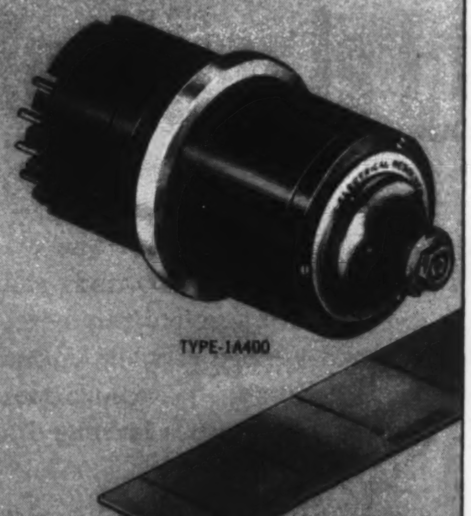
LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.

---

*The use of "O" rings in certain packing structures is covered by Christensen Pat. No. 2,180,795 under which we have paid the royalty for the installation of our rings in these structures so that the royalty is included in the purchase price of the "O" ring.

To Top-Flight Development, Design and Instrumentation Engineers:



TYPE-1A400

The accompanying table gives the characteristics of Arma Electrical Resolvers. The accuracy of these components is indicated by the tolerances in transformation ratio (S/P), phase shift, and angular accuracy.

TYPE	FREQ.	IN-PUTS	OUT-PUTS	INPUT VOLTAGE	RATIO (S/P)	PHASE SHIFT	REQUIRED AUXILIARY UNITS
E	60	1	2	8	0.9750 ±.0010	6°20′ ±5′	Compensator
H	60	2	2	8			Two Compensators
J	60	1	2	0.5-16	0.989 ±.015	4°35′ ±60′	None
K	60	2	2				None
1A400	400 ±10%	1	2	0.5-16	1.0000 ±.0006	0°0′±3′	Booster Amplifier
1B400		2	2	0.5-16			
1C400		1	1	0.5-16			
1D400		2	1	0.5-16			
P	400	2	2	0.5-16	0.98±.02	75′±20′	None

Maximum Angular Inaccuracy Is 0.1% x (S/P) x Input Voltage
Operating Temperature Range for All Resolvers = 0° to 55° C
**One Booster Amplifier may be used for two (2) Resolvers of this type.*

New Approaches to New Horizons Are Opened by These Resolvers*...

They offer an accurate and dependable means of solving problems involving the trigonometric functions . . . for applications in electromechanical computing and control equipment . . . until recently highly restricted.

Arma Resolvers Are Computing Components

The Arma Electrical Resolver is an electromagnetic unit designed to deliver two alternating voltages proportional respectively to e_1 sin A plus e_2 cos A and e_1 cos A minus e_2 sin A, where e_1 and e_2 are the voltages applied to the two primaries and A is the angle through which the rotor has been turned from the position defined as electrical zero.

They Solve Problems Involving Triangles, Coordinates, Vectors

Problems such as the rotation of coordinates, solution of triangles for angles or sides, addition of angles, transfer between rectangular and polar coordinates, and the resolution, composition or addition of vectors are readily solved using Arma Electrical Resolvers. Angular inaccuracy defined in terms of difference between actual and theoretical output voltages for any rotor position is always less than 0.1% of (S/P) x input voltage.

The Results are Fast and Accurate

Arma Electrical Resolvers may be regarded as high-precision signal transformers with continuously variable ratio. In common with other electromagnetic devices there are changes in the inherent transformation ratio and phase shift caused by changes in frequency, temperature or primary voltage. Arma resolver design recognizes these factors and gives results of extreme accuracy.

Advantages of Arma Resolvers Over Wire-Wound (Potentiometer Type) Units

1. *Stepless operation — outputs are smooth accurate sine or cosine functions uninterrupted by "wire stepping."*
2. *Unlimited rotation with no circuit interruptions.*
3. *No wear; indefinite life with no change in accuracy.*

Use These Other Arma Components, Too

Here are possible applications of other Arma components released for private industry which invite interest: Tachometer-type Induction Generators for high performance servo systems; two-phase Induction Motors for servo mechanisms and control devices; Synchro Units (better than Navy "Specs") for remote control and indicating purposes; high-precision Mechanical Differentials for computer applications.

How Ideas Become Realities

For over 30 years Arma Corporation has been quietly taking on (under wraps) one complex development and design problem after another for the U. S. military establishments—problems concerned with instrumentation. In the initial stage these problems may be little more than a gleam in someone's eye, a vague hope, a "dream"! That's where Arma *starts.*

When Arma *finishes,* the problem is not only solved but the actual equipment to do the job, *built*—whether it be a complicated gun director, a gyro compass or a complex remote control system. Arma follows through to practical realities.

You are invited to request whatever information you may need to explore the possibilities of making use of any Arma product which has been released from security restrictions.

ARMA CORPORATION
254 36th STREET, BROOKLYN 32, N. Y.
SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS • ARMA SYNCHROS • ARMA INDUCTION MOTORS • ARMA INDUCTION GENERATORS • ARMA MECHANICAL DIFFERENTIALS • ARMA ALTERNATING VOLTAGE COMPARATOR • COMPUTING MECHANISMS • INDUSTRIAL CONTROLS • STABILIZATION DEVICES • NAVIGATIONAL EQUIPMENT • ARMATRON AUTOMATIC INSPECTION SYSTEM

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QUALITY ARMA INSTRUMENT PRECISION

FLAT BELTS AND BELTING
by
Gilmer
for
✓ GENERAL INDUSTRY
✓ SPECIAL PURPOSES
✓ TEXTILE MACHINERY
L. H. GILMER COMPANY
Gilmer BELTS

GILMER has the PULL

and the New Flat Belt Catalog you need!

You find new Belts—new data—new convenience in this latest complete catalog of Gilmer Flat Belts and Belting. It's easily readable and handy to use and tells why you get more out of any recommended application.

Besides a selection of special Belts to solve various power transmission problems, you find belts ranging from high torque, heavy duty service to light duty belts for minimum pulleys and maximum speeds. The well known Gilmer Kable Kord Belt in the unique two-belts-in-one design is featured.

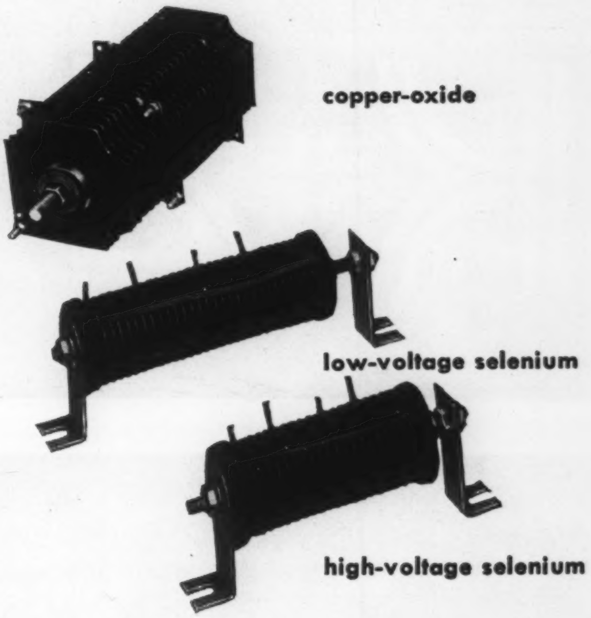
Gilmer specializes in belts, including V-Belts and the amazing Gilmer "Timing" Belt that operates at zero slippage, opening up new possibilities in machine design.

Send for the new Gilmer Flat Belt Catalog . . the "Timing" Belt Data Form . . . or the Gilmer V-Belt Guide. Free.

L. H. GILMER COMPANY
Tacony, Philadelphia 35, Pa.
DIVISION OF UNITED STATES RUBBER COMPANY

GILMER SPECIALIZES IN BELTS

And which Metallic Rectifier Is Best?



No one type is "best." Each type of rectifier has characteristics which made it a "natural" for a particular application. For every application there is usually one best type. The correct choice depends upon the application. Here are general recommendations!

GENERAL RECOMMENDATIONS

Where you want	*Use*	*Because*
Small size	High-Voltage Selenium	Except for 12 volts and below, fewer high-voltage selenium cells are needed.
Light Weight	High-Voltage Selenium	Selenium-on-aluminum cells are much lighter than copper-oxide.
High Power for a few seconds	Copper-Oxide	Both types will withstand high short-time *current* overloads but only copper-oxide will withstand the higher a-c voltage necessary to deliver short-time high power output.
High current with Low Voltage	Fan Cooled Copper-Oxide	While with fan cooling, selenium can operate at higher current densities than copper-oxide, efficiency will be lower. Copper-oxide aging remains stable.
High Voltage	High-Voltage Selenium	Fewer selenium cells are required.
Low Current at 6 volts or less	Copper-Oxide	Cell for cell, copper-oxide costs less than selenium. Where the minimum number of cells of either type is required, copper-oxide will be *cheaper*.
Long life with unchanged output	Copper-Oxide	While both types appear to have unlimited life. Characteristics of copper-oxide do not change after the first 6 to 12 months of continuous operation. Selenium continues to age—to build up internal resistance with time and particularly with high current densities.
Blocking in D-C Circuits	Copper-Oxide	Selenium tends to "unform" when used as a check valve in d-c circuits or when idle for a period of time (though it reforms quickly when reverse voltage is impressed).
Resistance to Corrosive Atmosphere	Oil-Filled Selenium	Stacks are hermetically sealed in oil, protected against fumes, dirt and dust.

Low-voltage selenium is generally recommended as a compromise between copper-oxide and high-voltage selenium. Where some of the features of both high-voltage selenium and long life copper-oxide are desired, low-voltage selenium would be a logical choice.

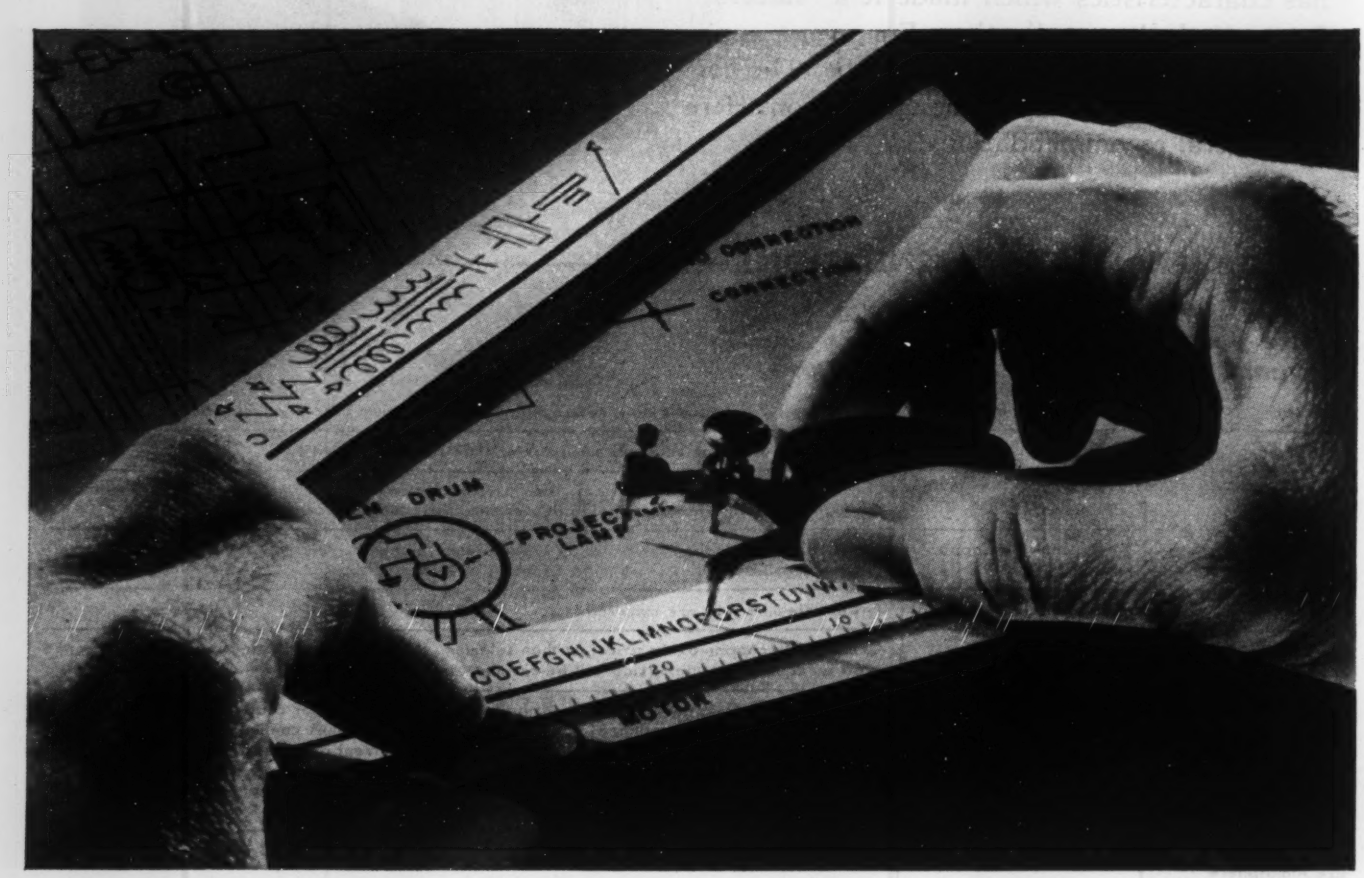
To fully meet your needs General Electric makes all three types. If you have a rectifier problem, bring it to us. As we make all three types, we play no "favorites." You can expect an impartial recommendation. Contact your G-E Apparatus Agent or write *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

456-14

partners

For 82 years K&E equipment and materials have been



YOU LETTER FASTER, BETTER WITH LEROY* EQUIPMENT

Lettering and symbol drawing is uniform and quick when you use LEROY "controlled lettering" equipment. It requires no special skill or training. You can form perfect letters on the very first trial . . . develop speed with a few minutes of practice. LEROY uniformity guarantees the same crisp, precise lettering on all your drawings. Moreover, LEROY lettering is free from the risk of smearing because the template is always well below the working line.

LEROY equipment offers a wide variety of alphabets and sizes, including Regular Gothic; Reversed, Condensed, Extended and Outline Gothic; Cheltenham; Greek; Isometric alphabets and ellipses; Electrical, Map and Welding symbols. In addition, K&E can make special LEROY templates with your own words, phrases, designs, symbols or trade marks.

You may start your LEROY equipment with a single template, scriber and pen; or you may choose one of the complete LEROY sets that will give you a full lettering range.

Ask your nearest K&E Dealer or Branch for a demonstration of LEROY equipment or write to Keuffel & Esser Co., Hoboken, N. J. for the LEROY Booklet.

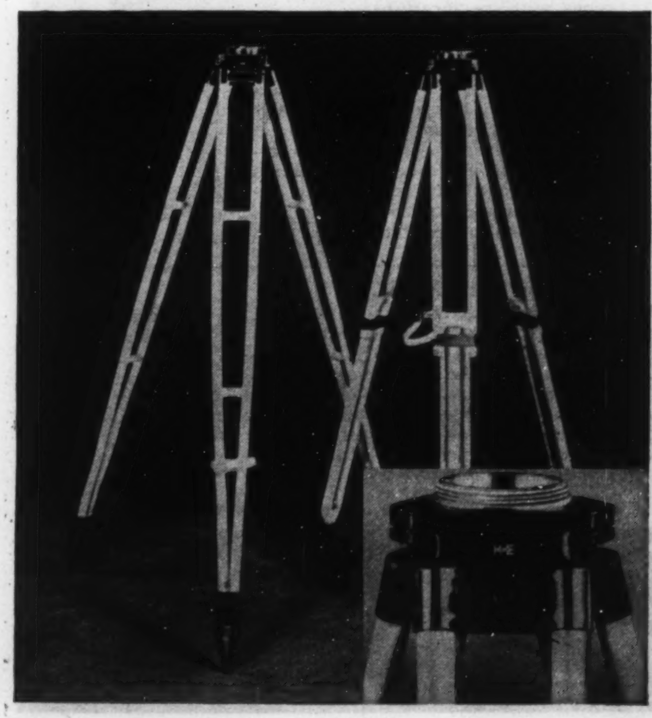
Wichita City Library

in creating...

partners of the draftsman, the engineer and the scientist in shaping the modern world

NEW K&E WIDE FRAMED TRIPODS GIVE MAXIMUM STABILITY

The wide framed leg construction of these new K&E tripods and the wide, all-metal hinges joining the legs and head result in great torsional stability. This makes the instrument much steadier—less vibration—in windy weather. Legs are straight grained maple. They are easy to plant firmly, because of their long steel "Stoodite" tipped shoes and large spurs—the kind a man can get his foot on, even with boots or galoshes. The head fits all instruments with the standard 3½ inch by 8 threads. K&E Wide Framed Tripods are made in stiff leg and extension styles. Ask your K&E Dealer or Branch to show you these tripods, or write to Keuffel & Esser Co., Hoboken, N. J.



K+E
ALBANENE

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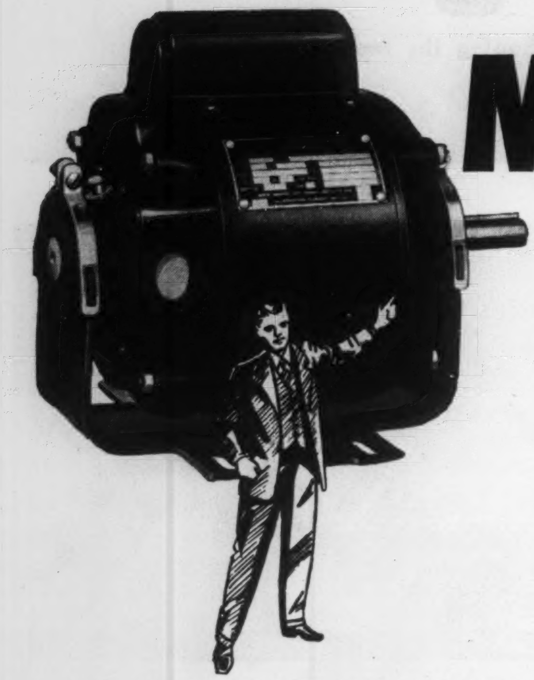
YOURS for the asking...

EMERSON-ELECTRIC

MOTOR FACTS



If You Have Applications for Motors, 1/20 to 5 H. P., You Can Use One or More of These Practical Data Bulletins

Here's motor information that Electrical Engineers and Appliance Manufacturers can *use!* Packed with pertinent specifications, construction details, and performance data, these Emerson-Electric Motor Bulletins furnish an authoritative reference guide in the selection of motors best suited to your applications. Emerson-Electric Motors are built to NEMA dimensional and operating standards. A request on your letterhead will bring you the Bulletins desired.

Write: The Emerson Electric Mfg. Co., St. Louis 21, Mo.

No. 110-J.

CAPACITOR-START MOTORS

Complete information on a full line of general-purpose motors from 1/6 to 3/4 H.P. Suitable for many types of pumps, compressors, machine tools, blowers, and other applications requiring a single-phase fractional H.P. motor.

FAN DUTY MOTORS

No. 113-J.

FAN-DUTY MOTORS

America's leading fan manufacturer furnishes reliable finger-tip information on a complete fractional H.P. motor line, specially designed for applications with a fan blade mounted directly on the motor shaft. Single- and two-speed split-phase, split-capacitor, polyphase, and D.C. types, with specifications.

SPLIT-PHASE MOTORS

No. 111-J.

SPLIT-PHASE MOTORS

Specifications and construction features of both general- and special-purpose motors for a host of applications. Sleeve- or ball-bearing types; totally enclosed or open-protected; rigid or resilient mountings; thermal protectors. Ratings from 1/20 to 1/3 H.P.

EMERSON ELECTRIC

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OIL-BURNER MOTORS

Performance curves, dimensional data and construction features on specially designed oil-burner motors, based on 58 years of research, design and precision manufacturing to meet the problems of oil burner applications. Totally enclosed, streamlined, quiet-running . . . built for continuous trouble-free service. 1/6 H.P.

INTEGRAL HORSEPOWER MOTORS

No. 112-J.

INTEGRAL MOTORS

Emerson-Electric Integral Motors up to 5 H.P. are fully described, with construction details, performance curves, and dimensional data. Included are repulsion-induction, repulsion-start induction run, polyphase, and D.C. motors for a wide variety of applications.

No. 115-J.

JET PUMP MOTORS

This bulletin gives construction features, performance curves and dimensional data on motors developed especially for direct-drive jet pumps. The heart of a jet pump is the motor that powers it . . . an important reason for specifying motors that embody every dependable feature and design improvement achieved by a pioneer manufacturer of pump motors.

EMERSON ELECTRIC

EMERSON ELECTRIC

MOTORS • FANS APPLIANCES

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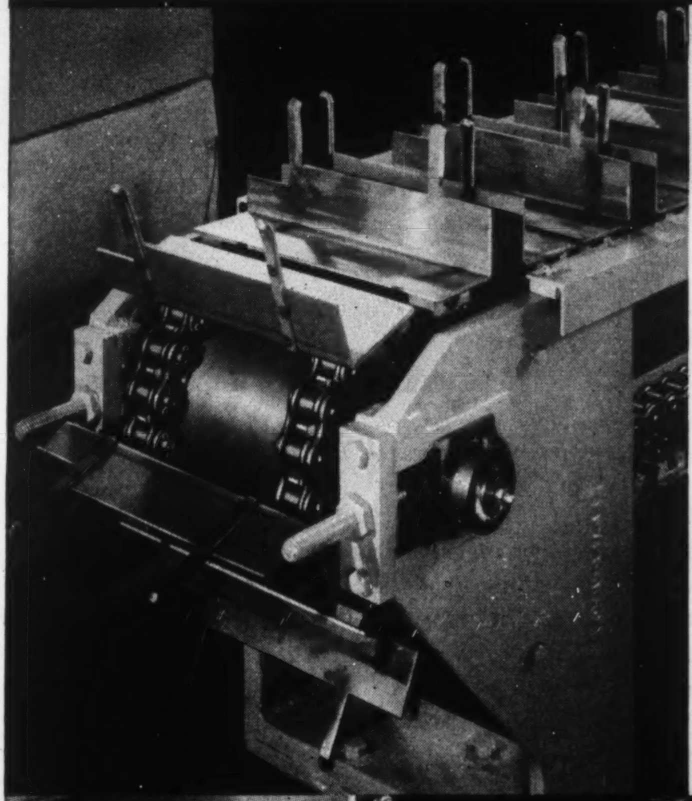
On Modern High Output Automatic Machinery

Where long-life dependability, accuracy of timing and conveying are vital . . . you'll find:

DIAMOND ROLLER CHAINS



• High speed automatic packaging and conveying machinery today pays its way through steady high output dependability. Here accuracy of timing and coordination of the various motions are all important.

Precision-made Diamond Roller Chains have established long time performance records on the finest machinery — for transfer of power from motor to main shaft, from shaft to shaft, and with various types of attachment links for packaging and conveying operations.

If you use or build automatic machinery, you find it pays to insist on DIAMOND Roller Chains. Practical suggestions from our specialized engineering staff are yours for the asking. Catalog 649 mailed on request.

DIAMOND CHAIN COMPANY, Inc., Dept. 435, 402 Kentucky Ave., Indianapolis 7, Indiana. *Offices and Distributors in All Principal Cities.*

Both illustrations show use of Diamond Roller Chains on packaging machinery made by the well-known firm R. A. Jones & Co., Covington, Ky.

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POWER DRIVEN
Brushes

on the job for
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ELECTRIC!

A Pittsburgh "power-driven" brush in operation at the Ambridge plant of the National Electric Products Corporation. Removing burrs, this special brush is on the job every day.

● Like many other leading industries, National Electric put their brushing problems before Pittsburgh's skilled brush engineers. Then Pittsburgh went to work to design and build a special brush for this rough assignment. The brush had to be *stiff* enough to remove burrs and scales. It had to be *tough* enough to penetrate and thoroughly clean the metal. And it had to be *rugged* enough to withstand heavy operation at high speed.

● You, too, can always depend on Pittsburgh to solve your brush problems. Its well-staffed crew of skilled engineers can solve your brush troubles quickly and effectively.

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- STEEL
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- RUBBER
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In the complete Pittsburgh line are brushes of all types, including "Perfect Balance" sections, wheels and assemblies. Consult the Pittsburgh engineering representative. He will gladly work with you in developing any type of power-driven brushes to meet your particular finishing specifications. Write or phone Pittsburgh Plate Glass Company, 3221 Frederick Avenue, Baltimore—29, Md.

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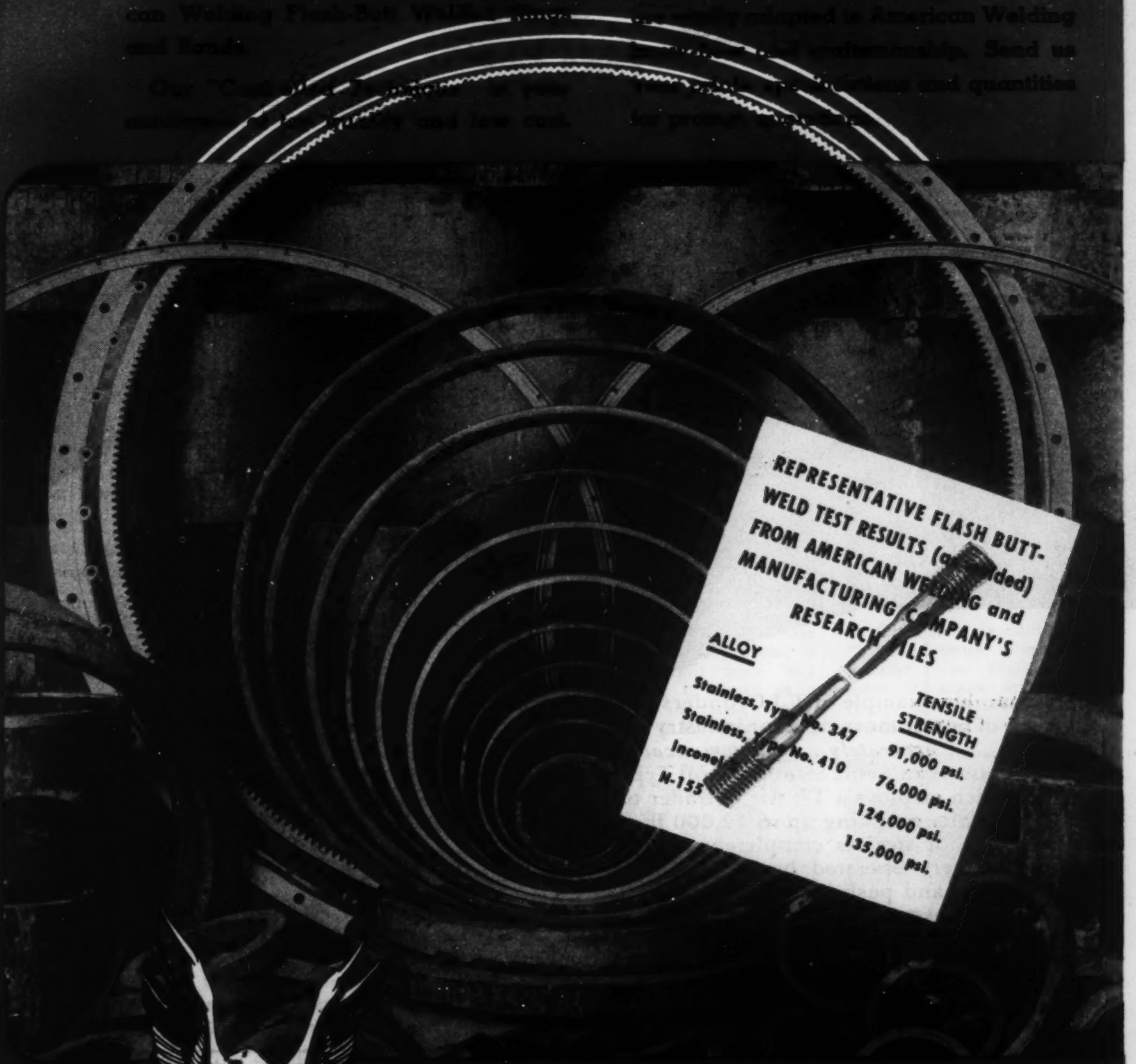

REPRESENTATIVE FLASH BUTT-WELD TEST RESULTS (as welded) FROM AMERICAN WELDING and MANUFACTURING COMPANY'S RESEARCH FILES

ALLOY	TENSILE STRENGTH
Stainless, Type No. 347	91,000 psi.
Stainless, Type No. 410	76,000 psi.
Inconel	124,000 psi.
N-155	135,000 psi.

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THE AMERICAN WELDING
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Job File No. 1001

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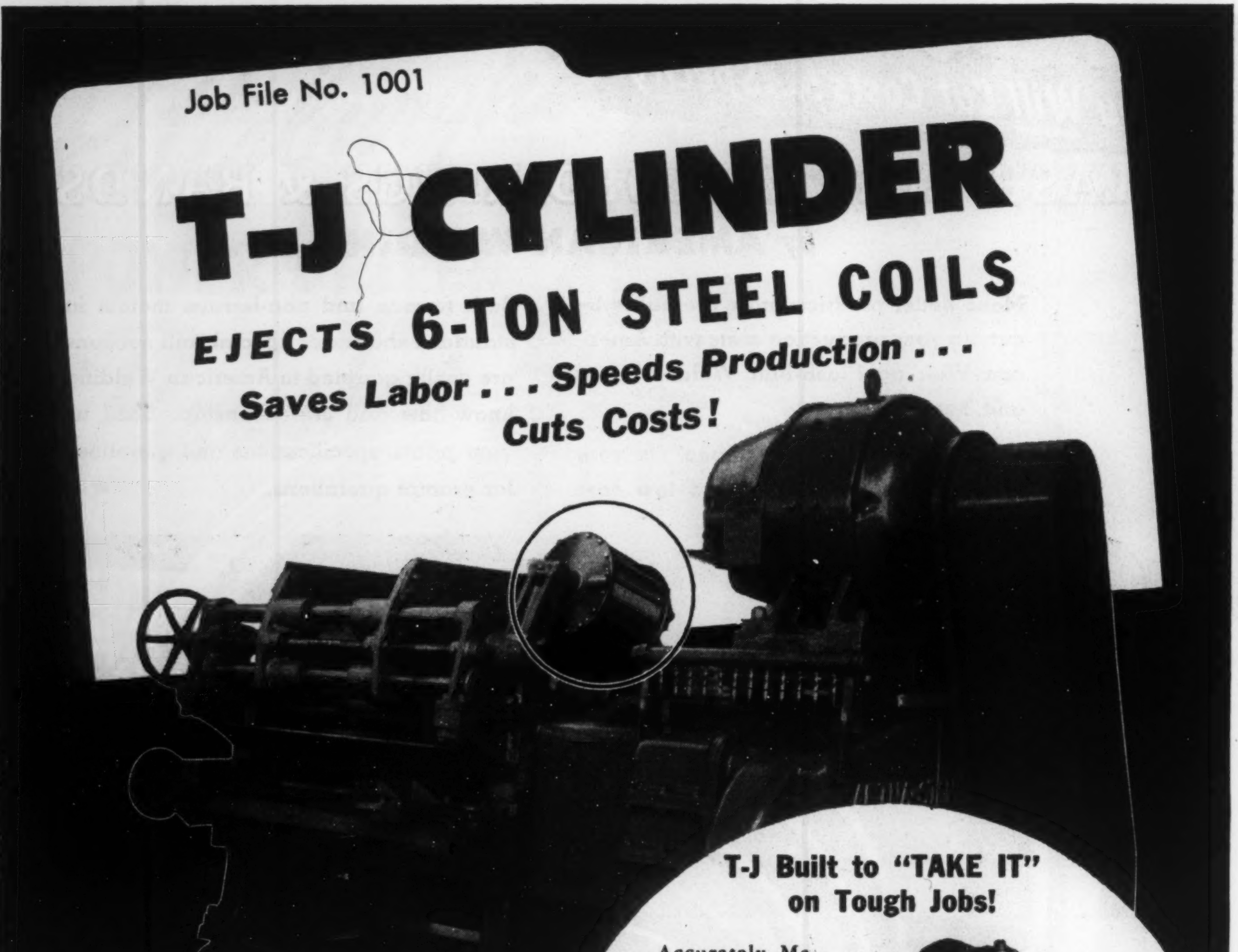
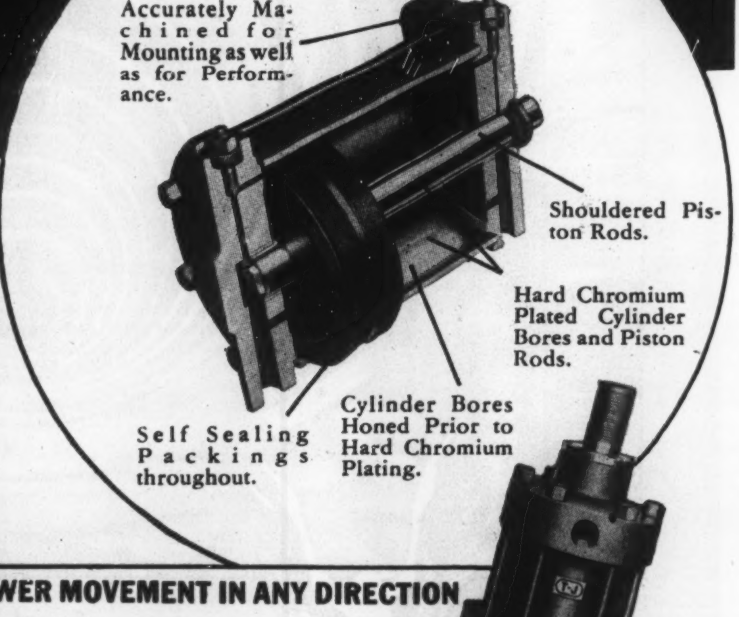
EJECTS 6-TON STEEL COILS

Saves Labor . . . Speeds Production . . . Cuts Costs!





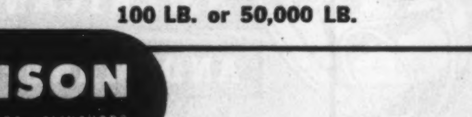
T-J Built to "TAKE IT" on Tough Jobs!

Accurately Machined for Mounting as well as for Performance.
Shouldered Piston Rods.
Hard Chromium Plated Cylinder Bores and Piston Rods.
Cylinder Bores Honed Prior to Hard Chromium Plating.
Self Sealing Packings throughout.

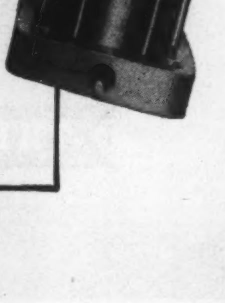
Here's another example of T-J Cylinders doing a job of power movement for industry . . . *efficiently . . . accurately . . . automatically.* This machine is an Aetna Standard Roll Type Coiler, which employs a T-J Air Cylinder to eject steel coils weighing up to 12,000 lbs.! As the strip of steel is completely coiled, kick-out fingers operated by the cylinder raise the coil and push it forward where it rolls on to conveyor.

T-J Air and Hydraulic Cylinders are built for 1001 tough jobs like this, where pushing, pulling or lifting is needed . . . 100 lb. or 50,000 lb. Available in many standard sizes and styles . . . both cushioned and non-cushioned types. Backed by 32 years' experience . . . built for long-life dependability. Write for latest catalogs. The Tomkins-Johnson Co., Jackson, Michigan.

FOR POWER MOVEMENT IN ANY DIRECTION



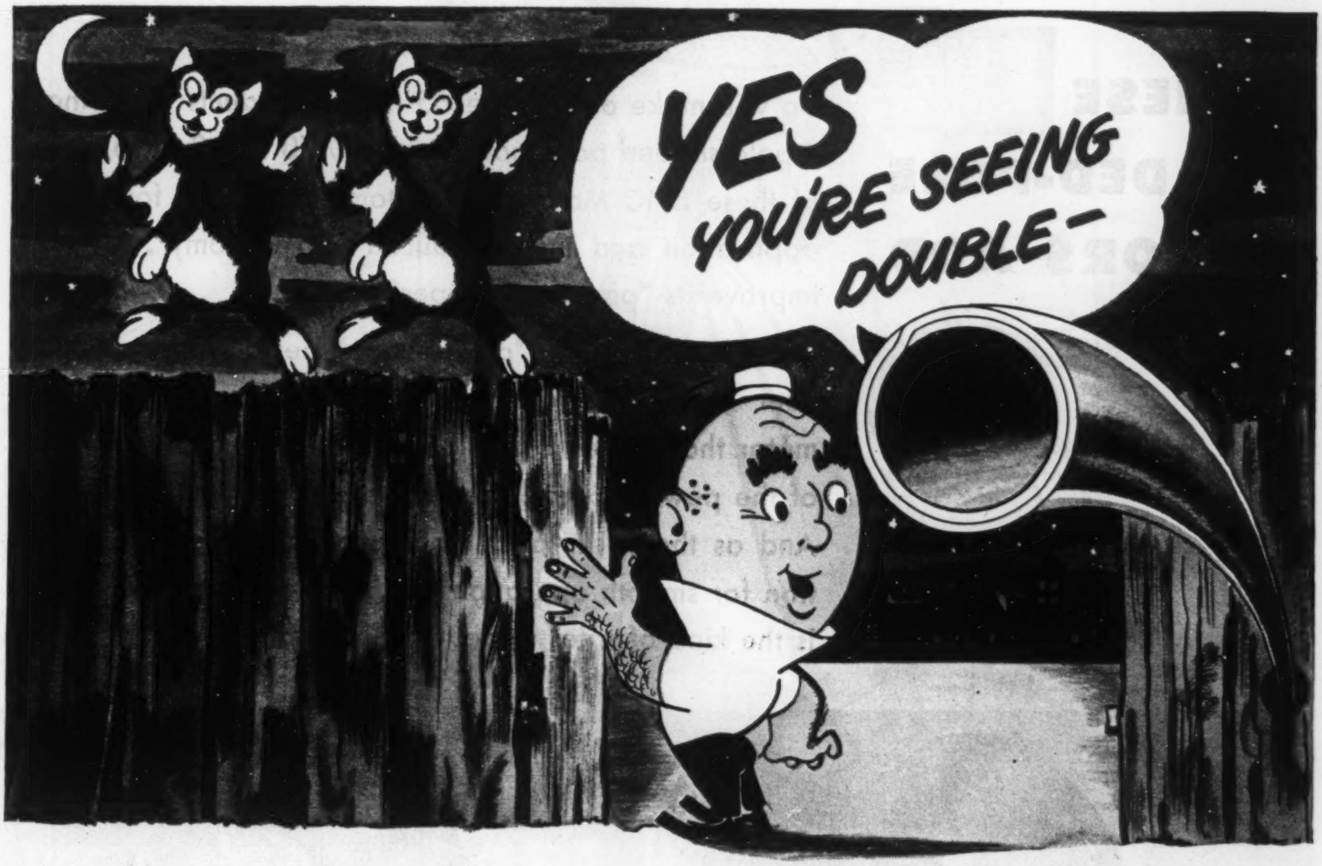
100 LB. or 50,000 LB.



T-J 32 YEARS EXPERIENCE

TOMKINS-JOHNSON

RIVITORS . AIR AND HYDRAULIC CYLINDERS . CUTTERS . CLINCHORS



—and so are thousands of other designers!

You're seeing the *double*-duty, *doubly* useful, *doubly* strong, *double-walled* Bundyweld* nickel and Monel tubing.

It's worth looking at twice! It's double-walled *from a single strip of nickel or Monel!*

Where can you use a tubing of amazing rust resistance and unbelievable strength? Bundyweld nickel and Monel are being specified for a wider and wider range of uses *—by more and more designers all the time!*

Did you say, "Such as?"

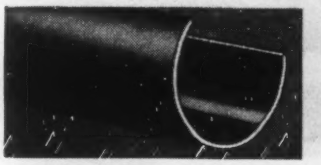
Such as fishing-rod tips of Monel: strong and *rustproof*. And nickel and Monel tubing parts in steam irons—to carry steam without sediment or stain. And nickel beer coils of *continuous* lengths up to *one hundred feet*—sanitary, thin-walled and fast-cooling, rigid.

What else can it do? You designers are *telling us* of uses we never thought of! Where can Bundyweld nickel or Monel tubing go to work for you?

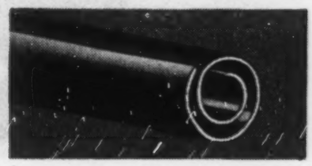
The patented Bundyweld construction makes it stronger, pressure-proof and easy to fabricate. These advantages and the features of Monel and nickel are combined for you in Bundyweld nickel and Monel tubing.

Want some help in working out an idea? Or more information about Bundyweld nickel and Monel? Send for booklet or contact one of the distributors below. *Bundy Tubing Co., Detroit 14, Michigan.*

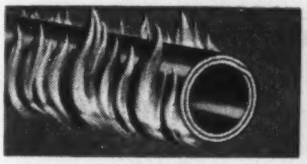
WHY BUNDYWELD IS BETTER TUBING



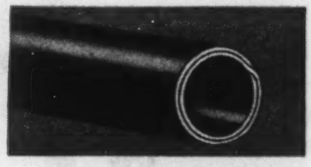
1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.



2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.



3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.



4 Bundyweld comes in standard sizes, up to ⅝" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING

★ ★ ENGINEERED TO YOUR EXPECTATIONS ★ ★

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THESE EMC SHADED-POLE MOTORS ADD *Sales Appeal* TO YOUR PRODUCT

Do you make one of the 65 major products requiring 4-pole shaded pole motors up to 1/70 h. p.? If so, one of these EMC Motors . . . custom-engineered for your application and mass-produced for economy . . . will improve its "power-zone" performance.

Reliable, unvarying "power-zone" performance keeps your customers from consciously thinking about the motor that makes it possible. When they are unaware of the power source, they think well of your product. And as the years pass, your product gains a reputation for smooth operation and a long service life. This is the kind of sales appeal EMC Motors add.

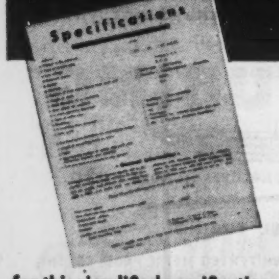
800-A

800-B

Smooth Operation . . . Long Service

800-C

800-D


Specifications

Write for this simplified specification sheet. In just a few minutes you can list all important product facts EMC engineers need to design a superior motor or gearmotor for your use. No obligation.

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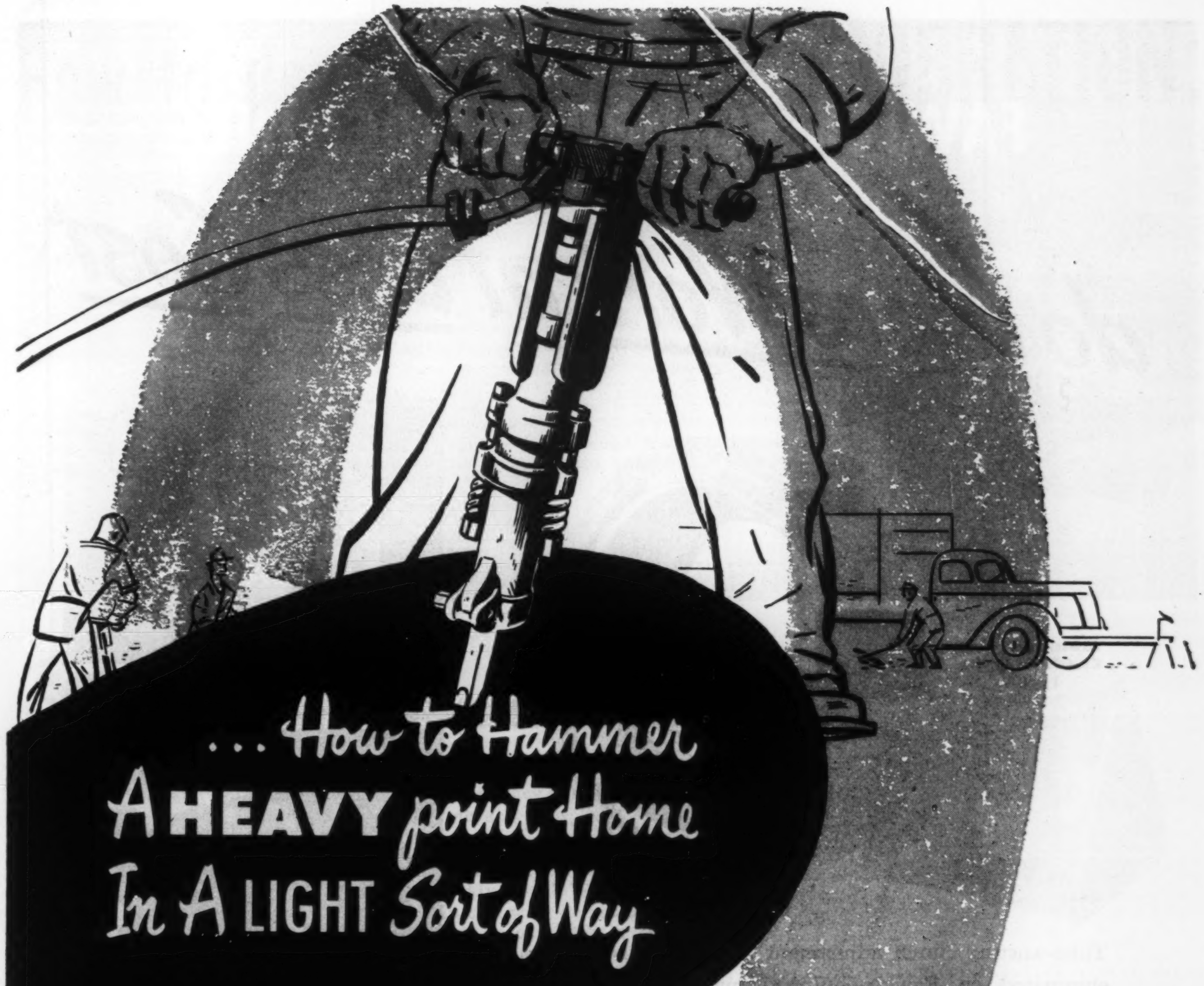
CUSTOM-BUILT FRACTIONAL H.P. MOTORS FOR ALL INDUSTRY



They used to do it with a sledge hammer—now a Well-Cast magnesium or aluminum casting helps. Pneumatic tools handle easily because of lightweight castings. *Any* manual equipment can be given the light touch with magnesium or aluminum castings.

These and similar products have proven strength, fast machineability and sales appeal.

37 years of Well-Cast experience can't help but help you. Write us today for Catalog No. 47.

Magnesium Portable Tool Part

Well Made Patterns, Permanent Mold and Sand Castings

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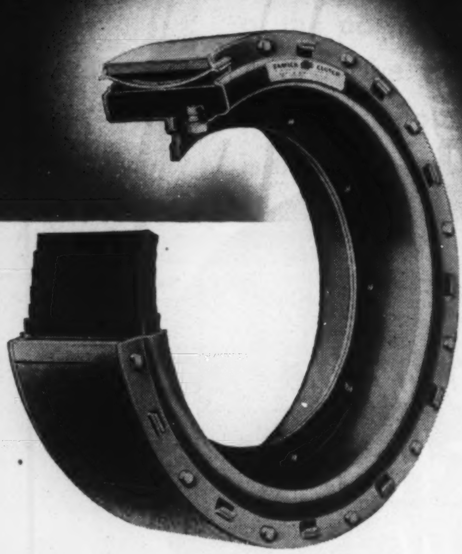
CASTINGS X-RAY INSPECTED

FAWICK-EQUIPPED MACHINES

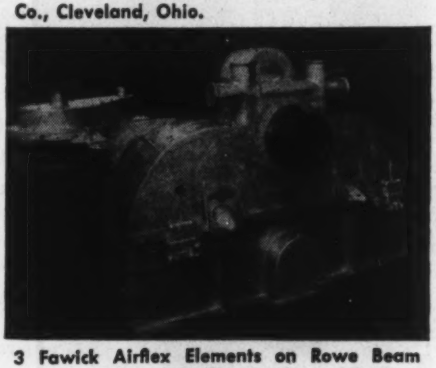
do More Work at Less Cost



Fawick Air-Ring Clutch or Brake Type E

30 Fawick Airflex Elements used on Block Oscillating Strip Steel Winder by C. L. Gougler Machine Co., Kent, Ohio.

Fawick Air-Ring Brake and Fawick Airflex Clutch on Canton 22A Shears by Hill Acme Co., Cleveland, Ohio.



3 Fawick Airflex Elements on Rowe Beam Travel Winch with Halibut Surdie and Brailing Attachment by Rowe Machine Works, Seattle, Washington.

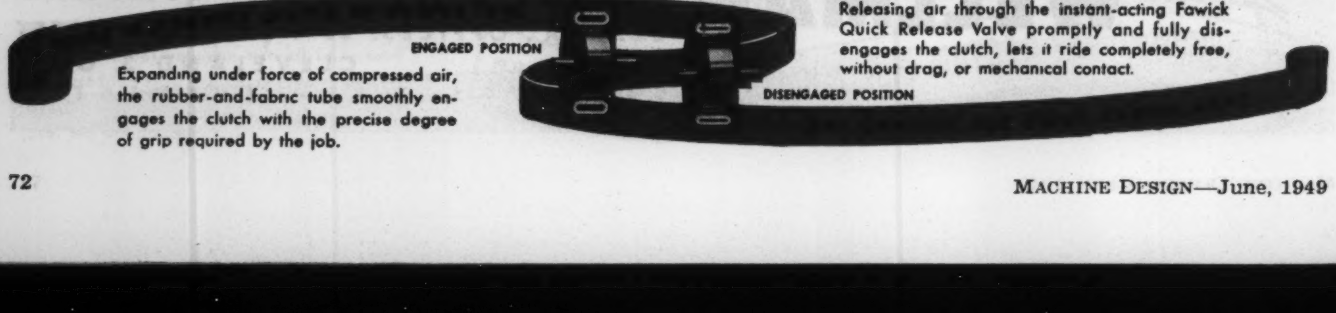
Time-wasting clutch adjustment down time is practically eliminated on Fawick-equipped machines. The moving parts of this Fawick Clutch—the rubber-and-fabric pneumatic tube and the friction shoe assemblies—adjust automatically and compensate for wear.

The smooth engagement action of this Fawick Clutch eliminates sudden shock loads which damage machinery. Controlled torque starting can be obtained with a simple modulating air valve. This type Fawick Clutch is ideally suited to continuous slip applications.

For specific recommendations for your machines, write to our Engineering Department today. Address Dept. MD.

FAWICK *Airflex* CO., INC.

9919 CLINTON ROAD
CLEVELAND 11, OHIO



Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.

How to deal effectively with VIBRATION:

Locate it-

...with an MB PICKUP

VIBRATION PICKUP

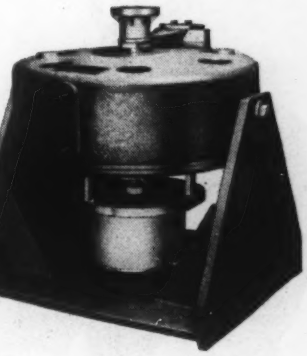
Any trace of vibration comes to light when you attach this sensitive electrical pickup to your product. A rugged, precision-built product, it will withstand rough treatment.

When bolted to equipment under test, this velocity-type pickup faithfully converts vibratory motion to an electrical output. Signal can be visualized with an oscilloscope. Major industries today find it indispensable for accurate analyses. Write for bulletin 124.

……

Reproduce it-

...with an MB EXCITER



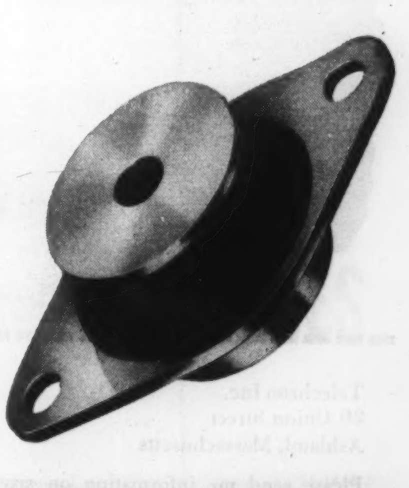
You can't beat this electro-dynamic exciter for shaking "bugs" out of products. With its frequency and force adjustments, you can "scan" a product for vibratory response—or fatigue-test it.

Take one case where a manufacturer of turbines was beset by blade failures. With an MB Exciter, he was able to resonate blades to destruction quickly—while studying their motions with stroboscopic light. In this way, he got to the cause of the trouble *visually!* More data in our bulletin 210B.

……

Isolate it-

...with ISOMODE* MOUNTS



Because Isomode mounts have equal spring rates in all directions, they're efficient at all angles — and they isolate all modes of motion!

That's why, by adopting Isomode units, one company was able to simplify suspension brackets and save on manufacturing costs in *addition to* improving vibration control! Another has been better able to cushion heavy duty engines—*without* redesigning the mounting system! Ask for bulletin 202 and Design Chart. ***Trade Mark Reg. U.S. Pat. Off.***

You can see why more and more engineers contact MB when they run into trouble with vibration. We'll be happy to cooperate with you on *your* problems. For more information and for bulletins on the above MB products, write to Dept. E 3.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street
New Haven 11, Conn.
VIBRATION ISOLATOR UNITS • VIBRATION TEST EQUIPMENT

VIBRATION DIVISION

the TRUTH about HEART TROUBLE

Why an electrocardiograph tells it

All around you, men and women are enjoying life today, who might have been cut down in the prime of life. But, thanks to the electrocardiograph, their span of life has been extended. By charting any abnormality of the heart's beat-strength or functioning, the electrocardiograph supplies the vital facts from which the physician determines whether, where or how severely the heart or heart muscles have been injured. Then he prescribes the proper treatment.

THE ELECTROCARDIOGRAPH CAN'T HAVE "HEART TROUBLE"

The heart of many of these life-savers is a Telechron Timing Motor... *instantly, constantly synchronous.* Only such an accurate, trouble-free motor can be trusted to time the chart that tells the truth about heart trouble.

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If you have a variable that must be controlled or recorded with split-second fidelity, a standard Telechron Motor, correctly applied, may be all you need. Ask a Telechron Application Engineer. He can give you the benefit of the broadest experience in the industry. The earlier in your planning you call him, the better are your chances of saving time, trouble and money. In the meanwhile, fill in and mail the coupon below for complete data on Telechron Synchronous Motors. TELECHRON INC., A GENERAL ELECTRIC AFFILIATE.

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Please send me information on sizes and types of Telechron Synchronous Motors. My possible application is:

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LOOK INTO CROLOY
16-13-3
(TYPE 316)
SEAMLESS & WELDED
STAINLESS STEEL TUBING

FOR MECHANICAL USES

Available also in modified analyses 18–13–3 (Type 317) for extreme corrosion conditions, and 16–13–3cb (Type 316cb) for applications where heat-treatment after welding is impractical. Ask for Bulletin TDC-133 describing physical, mechanical and fabricating properties of these analyses.

TA-1467-S

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SEAMLESS & WELDED **TUBES**

THE BABCOCK & WILCOX TUBE COMPANY
General Offices: Beaver Falls, Pa.
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A full range of Stainless, Alloy and Carbon Steel Tubing for all Pressure and Mechanical Applications

TRANSMITTER

Operate VALVES, THROTTLES, MACHINES, VARIABLE DRIVES . . .

Up to 1,000 FEET AWAY

SIMPLY, ACCURATELY, WITH THE ASKANIA ELECTRONIC SERVO SYSTEM

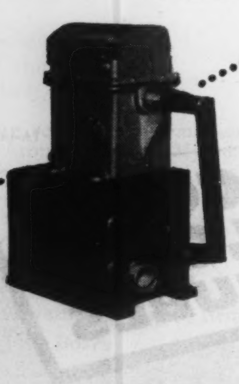
Consider the advantages of operating mechanisms from a remote point up to one thousand feet away — for equipment in a dangerous, inaccessible or inconvenient location. A central control system for several of the receivers is possible. Precise operation is assured by the system's accuracy of ¼ of 1%.

Operating on a standard 115 volt a-c current, the standard receiver shown in the illustration can offer torques up to 220 pound-inches. With the addition of a hydraulic cylinder, torques as high as 7,500 pound-inches can be achieved.

Almost any combination of the three units can be devised to permit multiple networks of transmitters and receivers.

All components of the system are constructed for heavy duty, rugged industrial operation. Dust-proof, cast metal cases withstand shocks, vibration and corrosion. All circuits and tubes can be reached easily without impairing the operation or original installation. Only two electrical supply line connections are needed for the entire system. Write for full information.

Accurate, powerful, simple remote control of dampers, valves, gates, throttles, pumps, machine tools, variable speed settings . . . can be achieved with a combination of the Askania Electronic System components shown in the illustration. A position signal selected at the transmitter or amplifier either manually or by means of cams, gears, or linkages causes the receiver crank arm to change position over a 90 degree arc.



ASKANIA Controls

Send for Bulletin 138 A

ASKANIA REGULATOR COMPANY

A Subsidiary of General Precision Equipment Corporation

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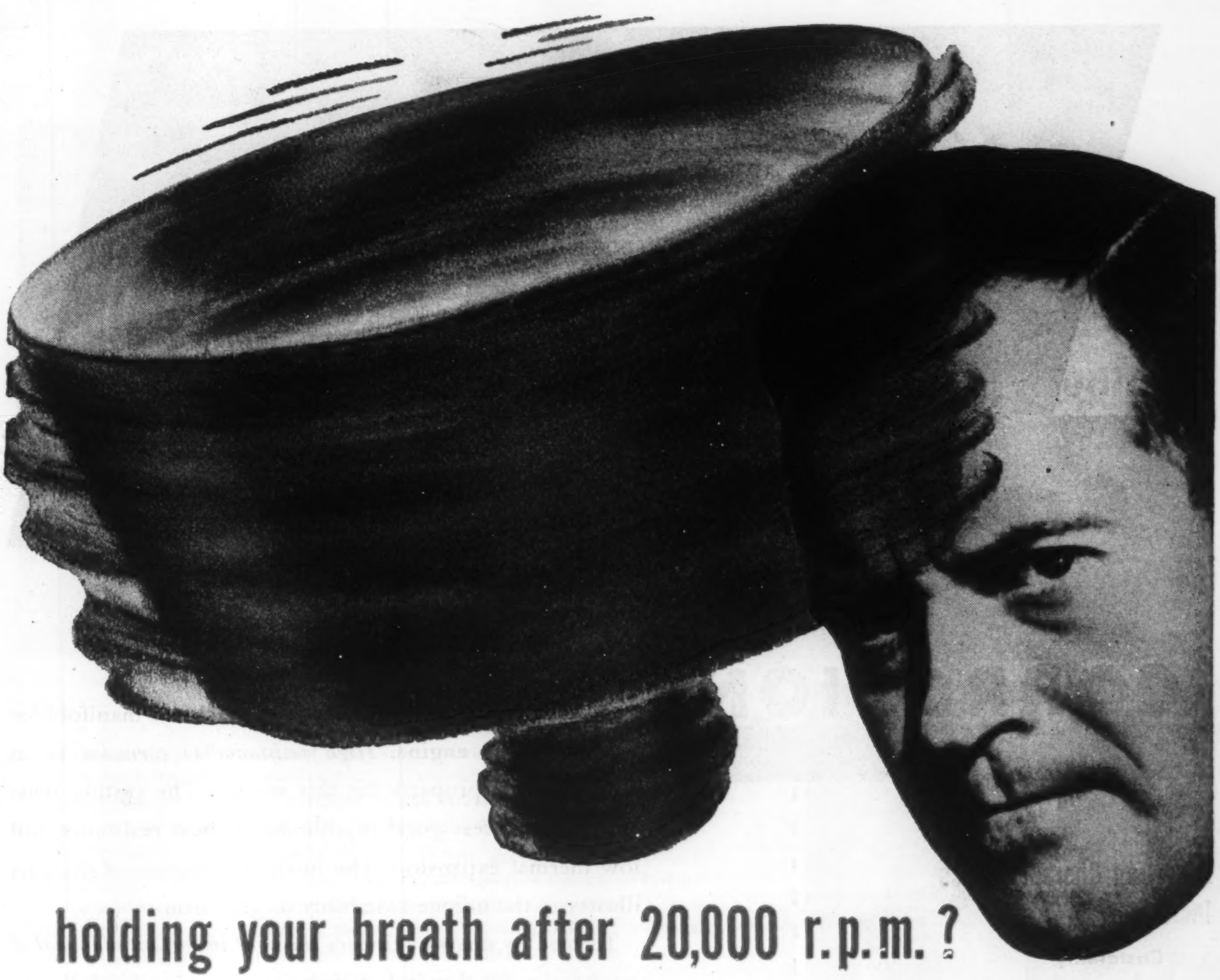

holding your breath after 20,000 r.p.m.?

No precedent here. You're going on faith . . . faith in your designs, in your materials. Be thankful if high-speed rotating parts are Alcoa Forgings. Their aluminum *lightness* reduces inertia, cuts centrifugal stresses to less than half. Their forged strength gives toughness where you need it.

Add corrosion resistance, fast heat transfer, easy machinability . . . and you begin to appreciate the design possibilities of Alcoa Forgings. It's worth investigating. Our forge shops are ready to tackle your problem. Just mail the coupon below, or call your nearby Alcoa Sales Office.

ALCOA ALUMINUM ®

Aluminum Forgings by

ALCOA

ALUMINUM COMPANY OF AMERICA
1940-F Gulf Building
Pittsburgh 19, Penna.

I would like to have full information on the advantages of aluminum forgings for the following application:

____

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Name__________________ Position__________

Company____________________________

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INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

Gray Iron resists CORROSION

● ● This gray iron casting is a water-jacketed manifold for a marine engine. *High resistance to corrosion* is an essential property for this service. The casting must also possess good machinability, heat resistance and low thermal expansion. The intricate structure of the part illustrates the unique castability of gray iron.

Termed by many engineers *the most important material of construction in chemical engineering,* gray iron's ability to resist corrosion is shown by its wide use in chemical plant equipment such as pumps, retorts, pipes, valves and fittings. Continuous service of cast-iron water mains for *over 100 years* is dramatic evidence of this property of gray iron.

Are you taking full advantage of the unmatched combination of useful properties offered by Gray Iron and its various alloyed forms . . . plus its ultimate economy?

Send for free booklet "GRAY IRON—Its Mechanical and Engineering Characteristics, and Details for Designing Cast Components".

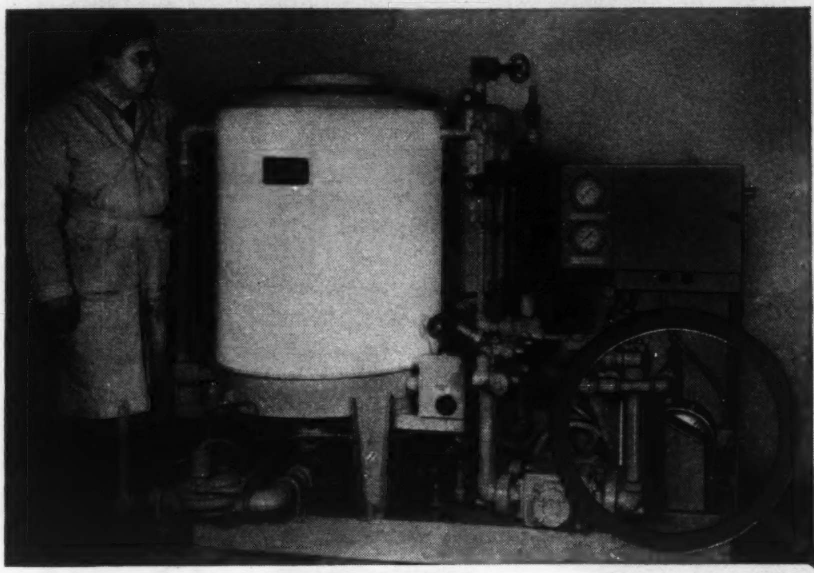
Gray Iron Characteristics Include:

- **Castability**
- **Rigidity**
- **Low Notch Sensitivity**
- **Wear Resistance**
- **Heat Resistance**
- **CORROSION RESISTANCE**
- **Machinability**
- **Vibration Absorption**
- **Durability**
- **Wide Strength Range**

Make It Better With Gray Iron

GRAY IRON FOUNDERS' SOCIETY, INC.
NATIONAL CITY BANK BLDG., CLEVELAND 14, OHIO

A. O. Smith Builds ELECTRIC MOTORS



SMITHway Electric Motors Now Power Hundreds of Products Including CLAYTON RE-CIRCULATING STEAM GENERATORS

The A. O. Smith research and engineering staff is at your service, to help integrate electric motor design with your product design, and to achieve the most efficient and economical product operation.

In addition to a standard line of general-purpose motors, the SMITHway line includes a broad variety of special motors to meet the exact power requirements of many modern-day machines and product applications.

If you are seeking improved product performance, or require special characteristics in your power component, consult A. O. Smith.

Write for Bulletin No. EM-152

CLAYTON STEAM GENERATORS deliver "packaged steam" to meet every need in dairies, canneries, laundries, kitchens, and for cleaning, sterilizing, dehydration, steam-processing. They are complete package (water tube) boilers ready to connect and operate. Fully automatic, they deliver quality steam in 5 minutes from a cold start, at full working pressure.

SMITHway ELECTRIC MOTOR, powering Clayton Model WO 30 hp shown here, is a 1½-hp, single or 3-phase, 4-pole standard horizontal motor. Other Clayton models use ½, ¾, 2, 3, and 5 hp SMITHway Motors.

Ask the A. O. Smith man about electric motors for both special and standard uses

24-HOUR NATIONWIDE SERVICE

The A. O. Smith Product Service Division provides fast, low-cost electric-motor service to more than 200 authorized service stations, on a 24-hour, off-the-shelf basis. Factory Service Branches and Warehouses at Union, N. J., Chicago, Los Angeles.

SMITH WAY
75th ANNIVERSARY
1874 · 1949

A. O. SMITH
Corporation

New York • Boston • Cleveland • Syracuse • Cincinnati
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Tulsa • Dallas • Denver • Seattle • Los Angeles • San Francisco
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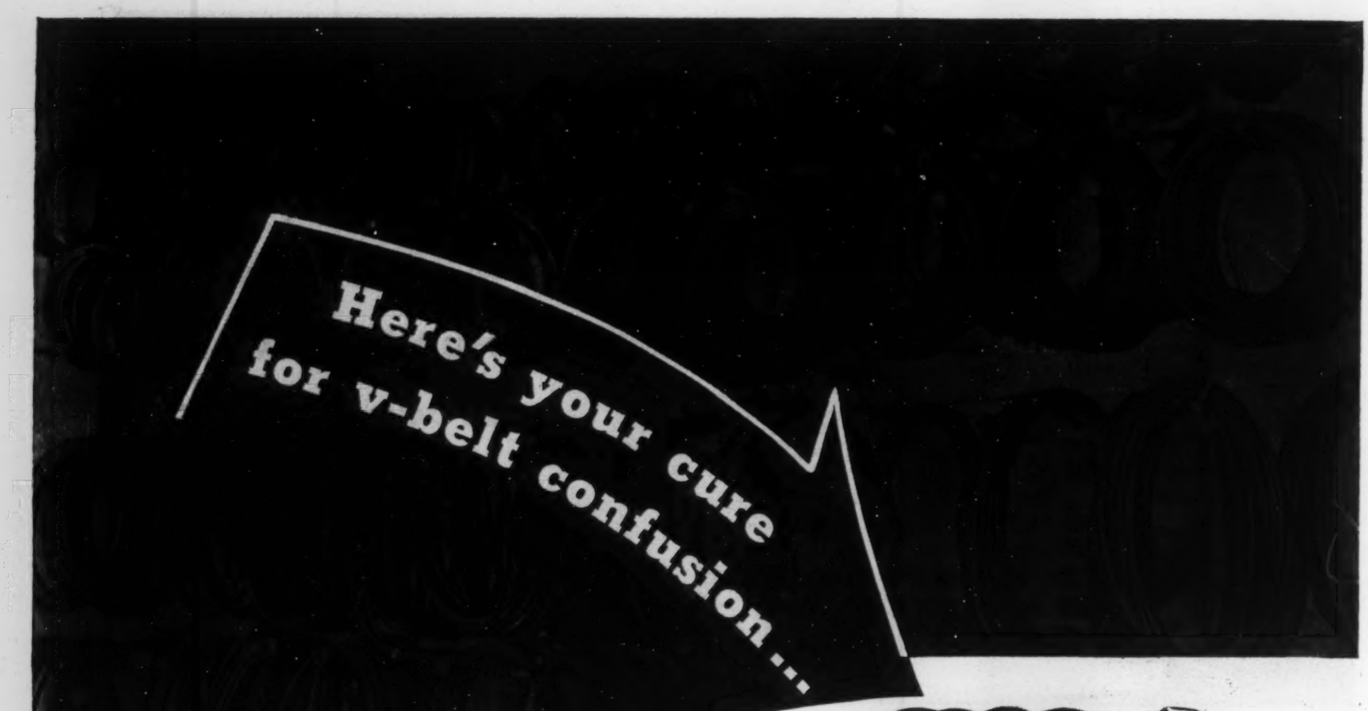
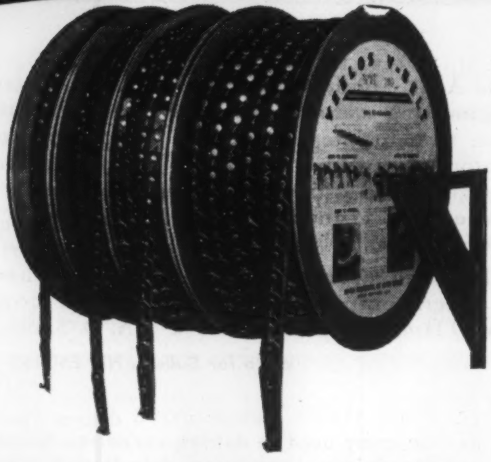




4 reels of VEELOS can replace 316 sizes of endless v-belts

HAS your v-belt inventory grown too large, too costly and too complicated by too many sizes of endless v-belts? No matter what size your inventory, Veelos can cut it—drastically!

Let's assume that you use O, A, B and C widths. With only four reels of Veelos you can make up more than 316 sizes of endless v-belts. If you use only A and B sizes, your entire v-belt inventory will be complete with just two reels. Any length belt is quickly uncoupled from a reel, made endless and installed.

Ease and speed of installing Veelos lowers machine downtime. On drives with outboard bearings, it is installed without moving the motor or dismantling the machine.

FREE VEELOS CATALOG shows how Veelos can bring many distinct v-belt advantages to your plant. See page after page of illustrations of Veelos at work in industry after industry. Full engineering data is given. Write for your free copy today.

MANHEIM MANUFACTURING & BELTING COMPANY
MANHEIM, PA.

VEELOS
THE LINK
V-BELT

ADJUSTABLE TO ANY LENGTH • ADAPTABLE TO ANY DRIVE

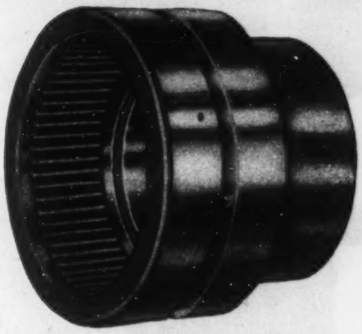
Made in all standard sizes, fits all standard grooves. Packaged on reels in 100-foot lengths. Sales engineers in principal cities; over 300 distributors throughout the country. Veelos is known as VEELINK outside the United States.

Bearing Facts
that have a bearing
on **Costs!**

- Finding the bearing exactly suited to your needs, is true economy . . . in your manufacturing costs, in operating characteristics of your product, in maintenance costs for your customers. Wherever your designs call for the bearing requirements listed on this page, the recommended Orange Roller Bearing will solve design problems—save space—speed up assembly—and provide quiet, long-life, trouble-free operation. Consult our engineers on any bearing application.

For High Load Capacity in Small Space...

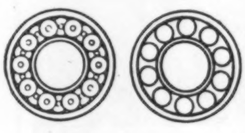
ORANGE ROLLER BUSHINGS



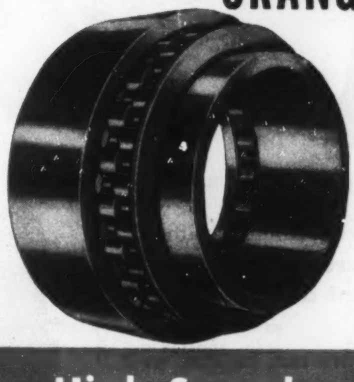
These anti-friction needle bearings are made to extreme standards of precision. Roller clearances are held to a minimum, providing closer internal running clearances. Possibility of misalignment is minimized. They have high load-ratings, run smoothly, quietly, and provide unfailing protection under heavy loads or high torque. Full range of sizes, with and without inner races. Send for Engineering Data Book.

For Heavy Duty Service...

ORANGE "*STAGGERED*" ROLLER BEARINGS



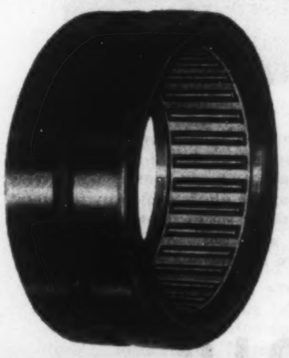
End views of Orange Staggered Roller Bearing and conventional bearings show how staggered roller design brings maximum roller surfaces in contact with load.



The use of short rolls and the unique staggered and meshed roller design, provides maximum supporting area in the loaded zone. Staggered bearings do the work of larger-size conventional bearings and stand up much longer in severe service. You can design to smaller sizes or use the higher load carrying for extra safety margin. Available in a full range of sizes, interchangeable with other solid race type bearings. Write for Engineering Data Book.

For Spindles . . . High Speeds . . . Vertical Applications . . .

ORANGE *Cage Type* NEEDLE BEARINGS



Cage holds rollers in permanent alignment with raceways. Ideal for high speed and spindle applications because internal clearances can be accurately controlled to meet exacting specifications. May be used on vertical or overhung applications—less affected by misaligned mountings. Extremely even-running, less internal friction. All rollers and raceways are "Pentrate" finished. Investigate Orange Cage Type Needle Bearings for countless spots impractical for conventional needle bearings. Write for Engineering Data

ORANGE ROLLER BEARING CO., INC.
556 Main Street, Orange, N. J.

Mail Coupon for Engineering Data

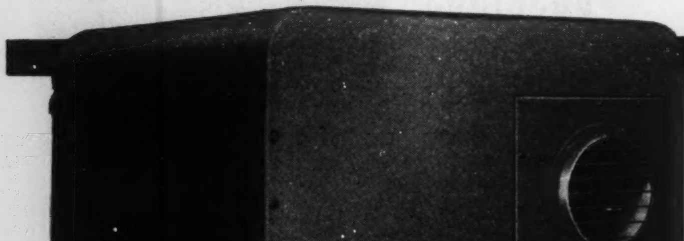
MD

Orange Roller Bearing Co.
Orange, N. J.

Please send full set of Engineering Data Books without obligation.

Name.................. Title..........
Company..................................
Address..................................
City.................. State..........

Designer's



New! UNIT-COOLED D-C MOTORS *that can't run a fever!*

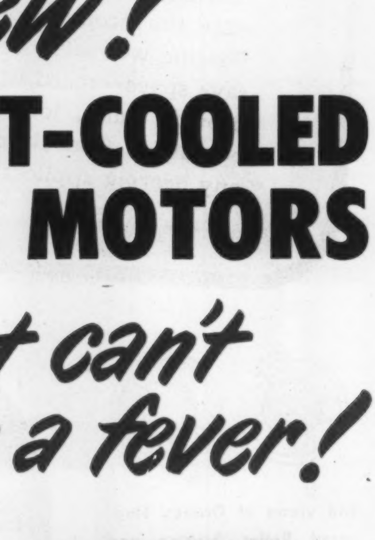
For applications where dirt, dust, or oil-laden atmospheres make it difficult to use open or partially enclosed motors, here's the newest improvement in General Electric standard, totally enclosed, unit-cooled d-c motors—ventilation entirely independent of motor speed.

In adjustable-voltage systems, these Type CD motors can be run well below full-field speeds over long periods of time and deliver full torque continuously, without danger of overheating. Full ventilation at all times is provided by a single Tri-Clad* induction motor driving two blowers at constant speed — one circulating internal air, the other external air.

Still available, to meet your limited speed range requirements, is the single-blower type. In this less expensive motor the internal cooling air is circulated by a shaft-driven fan.

With either type, no piping, ductwork, air filters or pressurized air supply are needed. Both are available in ratings from 15 to 200 hp. See Bulletin GEA-4469 for details of single-blower type; new bulletin on two-blower type will be available in a short time.

**Reg. U. S. Pat. Off.*



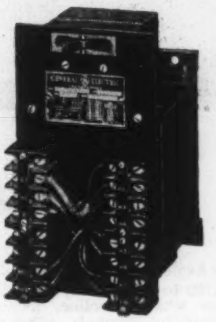
In this cutaway illustration of the G-E single-blower unit-cooled d-c motor, note how motor air, never in contact with contaminated outside air, is cooled by flowing through passages set at right angles to the external air passages. Safe winding temperatures are maintained at all times.

GENERAL ELECTRIC

Digest

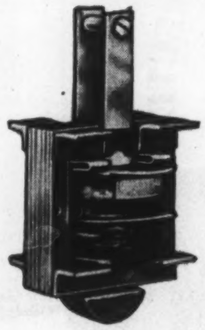
PRODUCT HIGHLIGHTS

MEETS MORE NEEDS— WITH ADDED RATINGS!



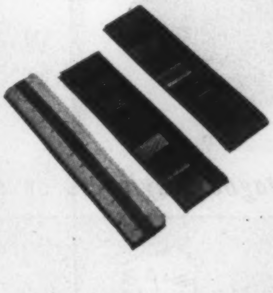
Yes, General Electric's standard line of machine-tool control transformers can now be applied to a greater variety of your designs. Five new additions have been made to the all-purpose (multi-tap primary) group, widening the available range to include ratings from 0.150 kva to 3.0 kva. These compact, versatile units save panel space, reduce inventory and storage costs, and contain built-in protection against damage from sustained overload. Many ratings are in stock, at attractive new prices.

PROVIDES PUSH OR PULL— ELECTRICALLY!



Need a reliable straight-line push or pull motion in your machine? It's a precision job with G-E heavy-duty solenoids, made in a complete line for a-c or d-c. Available maximum stroke distances range from ¾-inch up to 3 inches, and thrusts from 0.65 pounds up to 97 pounds. New bulletin gives complete information on ratings, plus a section on considerations in selecting a solenoid. See Bulletin GEA-5163.

GAGES ROUGHNESS— BY "RULE OF THUMB"!



Here's a handy, simple way to test machined surfaces by feel and sight. With General Electric pocket-size roughness scales, shop men can quickly check whether finished surfaces meet your specifications. Result: time spent on unnecessarily fine finishing and rejects due to insufficient finishing are both avoided. Set includes leather case and two 6-inch metal scales divided into 24 surfaces. Available immediately. See Bulletin GEC-311.

Now—bringing you more customer goodwill

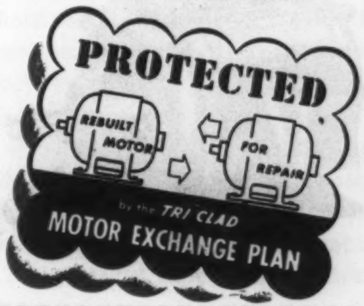
THE TRI/CLAD MOTOR EXCHANGE PLAN

REG. U.S. PAT. OFF.

You can now give your customers added assurance of operating continuity in the machines you equip with Tri-Clad motors—already the best-protected general-purpose motors money can buy. General Electric's new Tri-Clad Motor Exchange Plan relieves you of motor service responsibility, eliminates the need for you to maintain motor repair facilities. Your customer profits by extra down-time protection, lower-cost motor maintenance, and reduced spare-motor inventories.

How the plan works

If your customer's motor needs repair, his dealer or distributor exchanges it for a factory re-conditioned motor carrying a new-motor warranty—quickly, with no red tape. Inoperative motors are quickly replaced from the nearest of 16 General Electric motor-exchange centers. For full information on the plan see Bulletin GEA-5180.



General Electric Company, Section B668-74
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

( ) GEA-4469 — Unit-cooled d-c motor
( ) GEA-5163 — Heavy-duty solenoids
( ) GEA-5180 — Motor exchange plan
( ) GEC-311 — Roughness scales

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

Name...

Company...

Street...

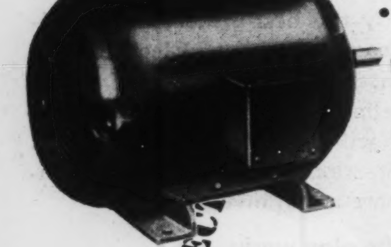
City......................... State.........

wherever motor hazards lurk... Specify **WAGNER**

PROTECTED MOTORS

Do you use motors in locations where dirt, filings, moisture, splashing liquids, acid fumes, explosive gases, or other motor hazards lurk? No matter how severe the operating condition, Wagner has the right motor for your purpose—adequately protected against such hazards. Five types of Wagner protected motors are shown below.

· PROTECTED · PROTECTED



1. Wagner Totally-Enclosed Motors . . . PROTECTED against dust, dirt, abrasives, steel chips, filings, acid fumes, and other harmful elements that may damage the windings and bearings.

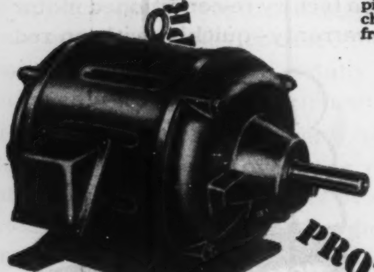
2. Wagner Explosion-Proof Motors . . . PROTECTED to prevent explosion in locations where gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors, or natural gas are manufactured, used, or handled. Approved by Underwriters' Laboratories for Class I Group D hazardous locations.

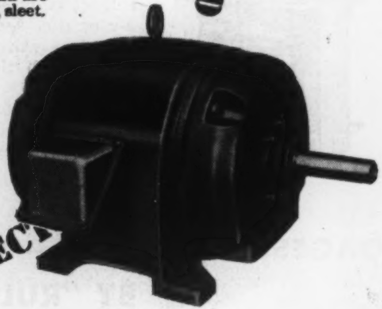
PROTECTED PROTECTED

3. Wagner Drip-Proof Motors PROTECTED to keep dripping liquids, falling metal chips and other particles from entering the motor.

4. Wagner Splash-Proof Motors . . . PROTECTED against splashing or dripping water, oil, or other liquids. They are widely used in exposed outdoor locations, and are completely self-protected against ice, sleet, snow and rain.

5. Wagner Chemical Plant Motors . . . PROTECTED to resist the action of acids, fumes, moisture and other harmful elements encountered in chemical manufacturing.





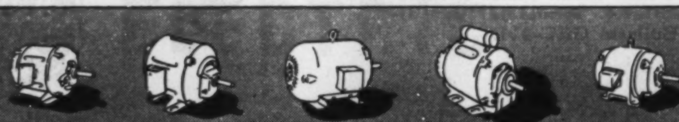
PROTECTED PROTECTED

Bulletin MU-185 gives full information on the complete line of Wagner Motors. Write for your copy today.

Wagner Electric Corporation
6404 Plymouth Avenue, St. Louis 14, Mo., U. S. A.

Consult Wagner Engineers on all Electric Motor Problems

Wagner Electric Corporation EST. 1891

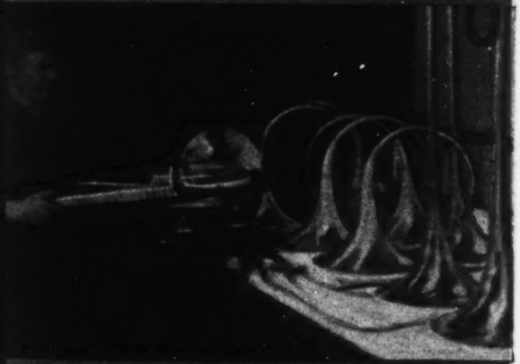


• ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE PRODUCTS •

M49-18

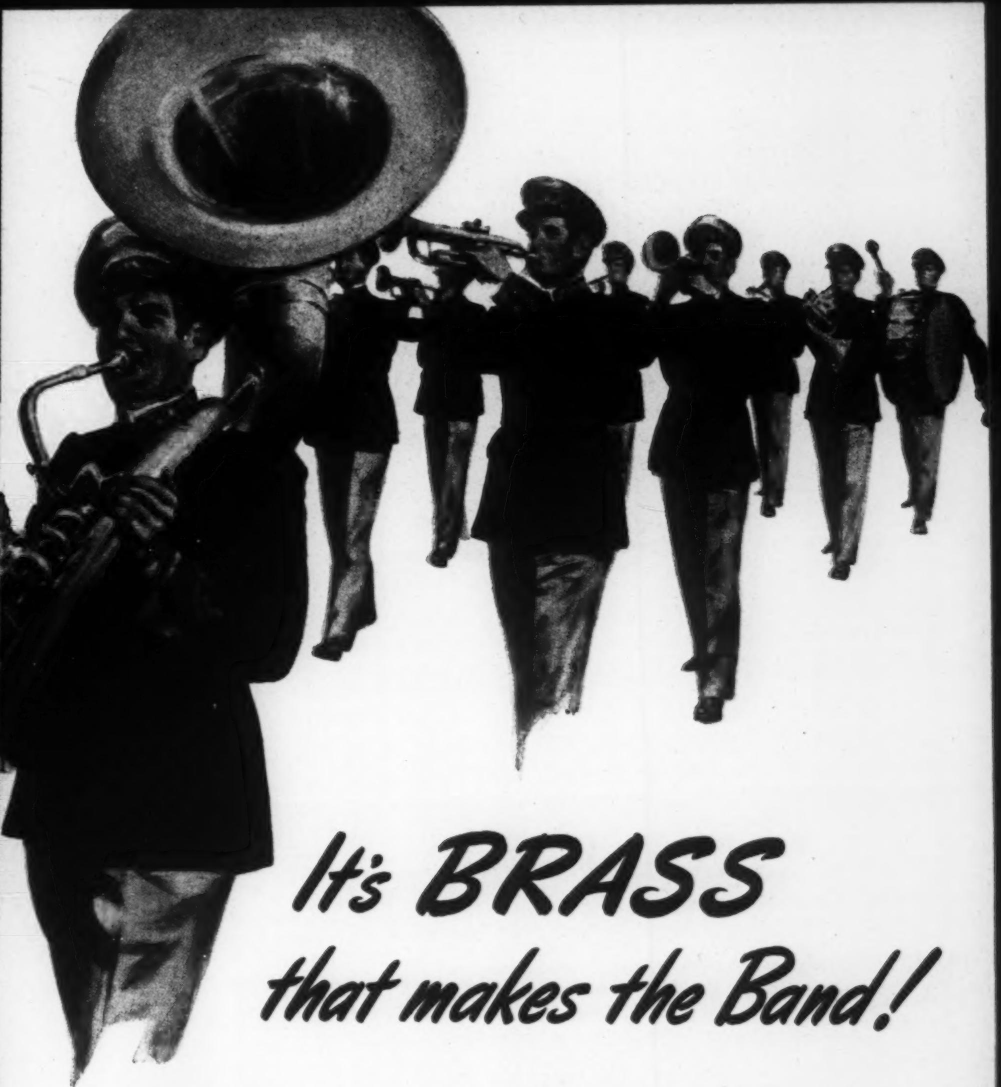
Forming the bell of a French horn is a highly skilled operation in which the bell bottom is spun from a flat disc of brass. Not only is the bell shaped, but the metal thickness is reduced.

The stem is formed from cartridge brass strip, 11" wide x .0179" thick. It is brazed on the seam and then brazed to the bell. The final spinning operation is over a tapered mandrel.



To obtain a uniformly smooth contour, both inside and out, the bell and stem are filled with pitch before bending on this bench fixture.

Skipping several hundred operations, we come to the finished instrument. It is now checked for pitch on the Conn Electronic Tester that measures tonal accuracy to 1/100th of a semi-tone.



It's BRASS that makes the Band!

When Col. C. G. Conn, the colorful Elkhart grocer who played in the town band, abandoned the cracker barrel for the tuba and the trombone in 1875, he bent his first horns to shape around tree trunks. But he started the industry that has made this nation the most musical on earth . . . a nation of three million young musicians, of 30,000 school bands and 35,000 school orchestras.

Since those early days, throughout the evolution of the Conn factory from a board shack to the largest and most modern in the world, Conn Instruments have been made from Brass and Nickel Silver supplied by The American Brass Company.

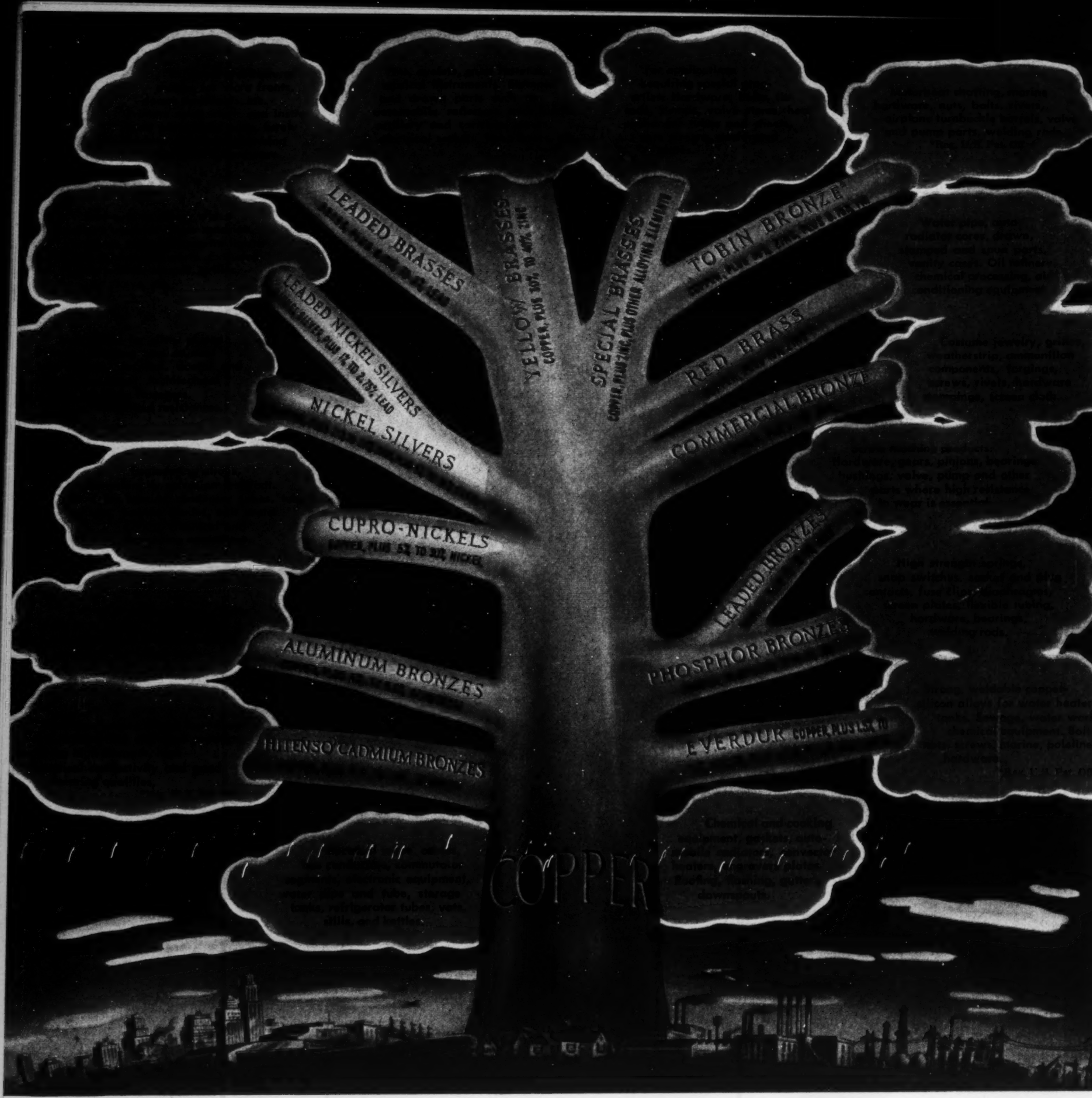
Well-known to both musicians and metal craftsmen are the many advantages that make brasses and other copper alloys indispensable for musical instruments. Only these metals can produce the tonal qualities desired . . . and only their ductility and ready workability can produce the flowing curves, the graceful tapers and glistening bells of modern band instruments.

"We have always found," writes Conn, "the copper alloys furnished by The American Brass Company to be consistently uniform in the properties so essential to our operations. And when we say this, it should be borne in mind that our standards of material testing and tonal precision are without equal in our field."

Uncompromising metal standards such as those set by C. G. Conn Ltd. are the expected thing in industry after industry specifying Anaconda Copper and Copper Alloys. How varied these industries are, and the alloys they require, are graphically indicated on the next page.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut


LEADED BRASSES
LEADED NICKEL SILVERS
NICKEL SILVER, PLUS 1% TO 2.75% LEAD
NICKEL SILVERS
CUPRO-NICKELS
COPPER, PLUS 5% TO 30% NICKEL
ALUMINUM BRONZES
HITENSO CADMIUM BRONZES
YELLOW BRASSES
COPPER, PLUS 30% TO 40% ZINC
SPECIAL BRASSES
COPPER, PLUS ZINC, PLUS OTHER ALLOYING ELEMENTS
TOBIN BRONZE
RED BRASS
COMMERCIAL BRONZE
LEADED BRONZES
PHOSPHOR BRONZES
EVERDUR COPPER, PLUS 1.5% TO
COPPER

Copper is the trunk of an indispensable family tree

The copper family of alloys is versatile, indeed. These dependable metals have contributed to the development of practically all technical and industrial progress. Other metals may have more distinctive properties. Chromium is harder; magnesium is lighter; silver has higher conductivity. But . . . of all commercial metals, copper and its alloys *combine to best advantage* a range of physical and chemical properties not found in any other group.

These properties include a high degree of corrosion resistance; high tensile strength and fatigue resistance; ductility, hardness and toughness; ready weldability; resistance to abrasion; hot or cold workability; machinability, and high thermal and electrical conductivity.

Yet, these very properties, singly or in combination, can be varied considerably by metallurgical adjustment of composition and by changes in the technique of fabrication.

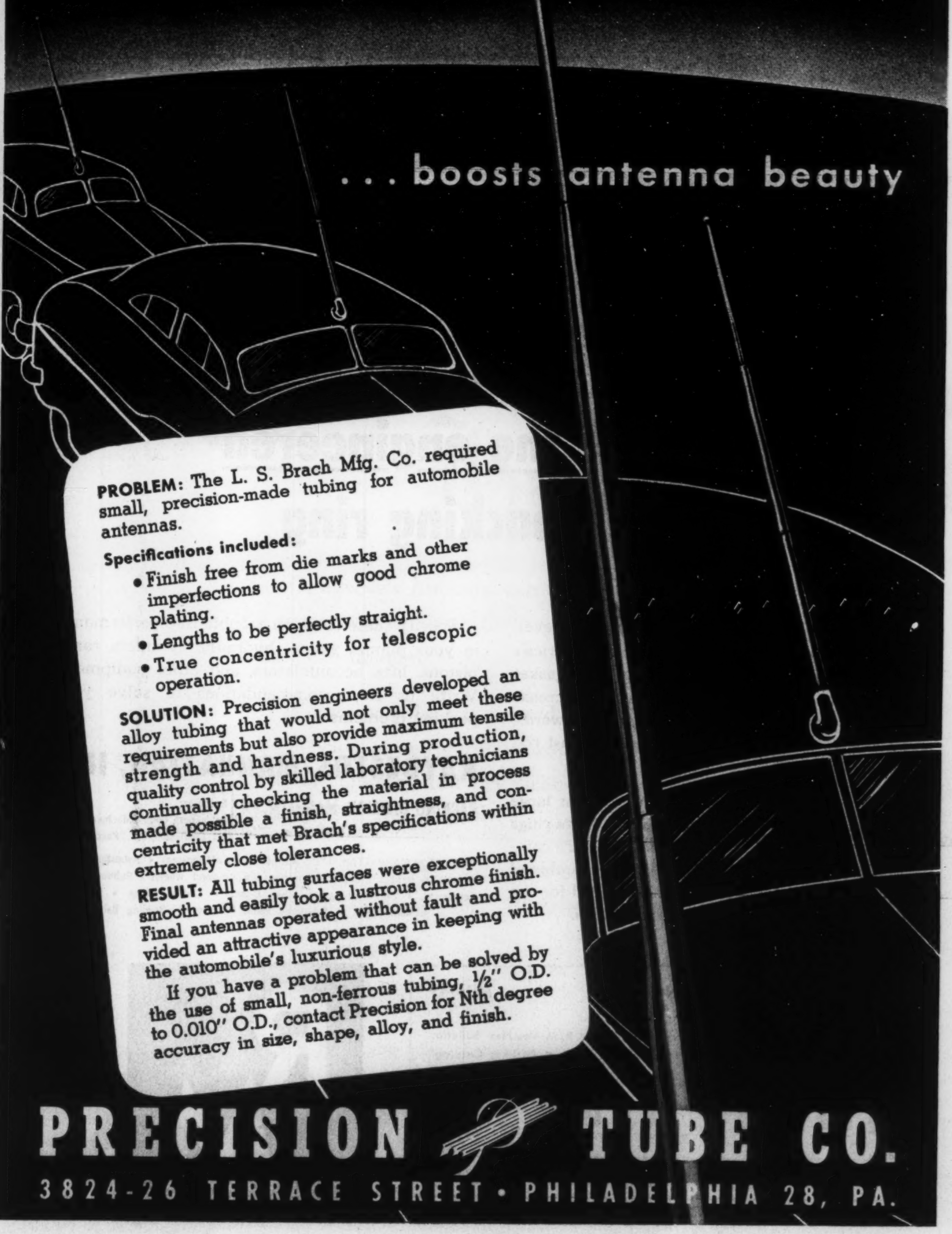
Our Technical Department will be glad to work with you in selecting the best metal for a specific application. 48123

ANACONDA from mine to consumer **THE AMERICAN BRASS COMPANY**
General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

Anaconda Copper Alloys

FINE TUBING FINISH

. . . boosts antenna beauty



PROBLEM: The L. S. Brach Mfg. Co. required small, precision-made tubing for automobile antennas.

Specifications included:

- Finish free from die marks and other imperfections to allow good chrome plating.
- Lengths to be perfectly straight.
- True concentricity for telescopic operation.

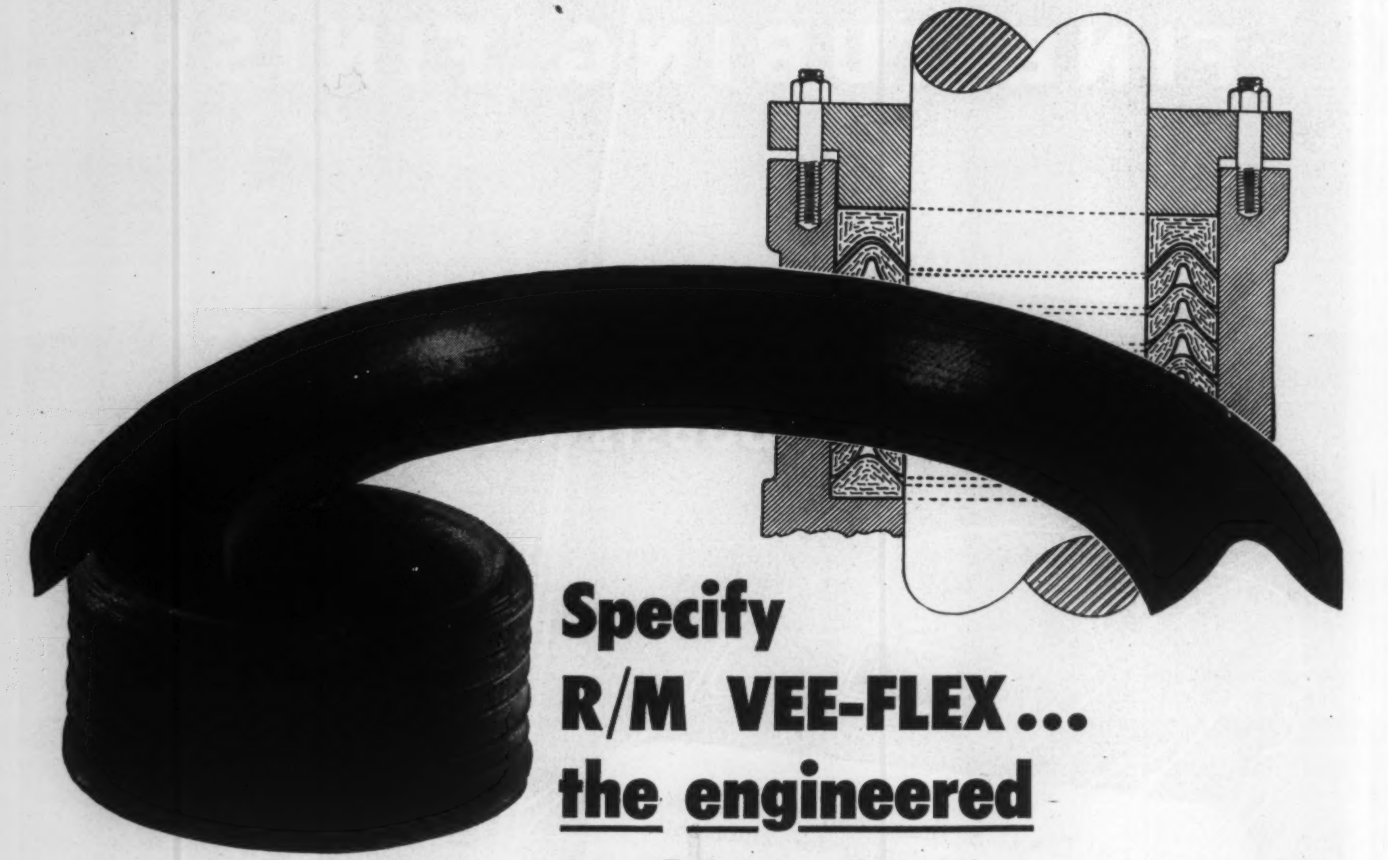
SOLUTION: Precision engineers developed an alloy tubing that would not only meet these requirements but also provide maximum tensile strength and hardness. During production, quality control by skilled laboratory technicians continually checking the material in process made possible a finish, straightness, and concentricity that met Brach's specifications within extremely close tolerances.

RESULT: All tubing surfaces were exceptionally smooth and easily took a lustrous chrome finish. Final antennas operated without fault and provided an attractive appearance in keeping with the automobile's luxurious style.

If you have a problem that can be solved by the use of small, non-ferrous tubing, ½" O.D. to 0.010" O.D., contact Precision for Nth degree accuracy in size, shape, alloy, and finish.

PRECISION TUBE CO.

3824-26 TERRACE STREET • PHILADELPHIA 28, PA.



Specify R/M VEE-FLEX... the engineered packing ring

The R/M Vee-Flex Packing ring has been developed over a period of years by one of America's foremost manufacturers of packing and gasket materials. The ring is so designed that any increase in pressure spreads the lips of the ring outwards, and increases the efficiency of the seal against rod or stuffing box wall.

The combined skill and experience of four large R/M plants are drawn upon to produce these rings with a high degree of accuracy. Materials are carefully selected for long service, and are so combined as to give the special characteristics needed for use in oil, gasoline, steam, milk and other fluids.

Specify these rings for trouble-free performance in your pumps, valves, hydraulic cylinders, rams, pistons, lifts, accumulators, and other equipment. Write us for recommendations to solve your packing problems.

RAYBESTOS-MANHATTAN, INC.

PACKING DIVISION, MANHEIM, PA.

Factories:
Bridgeport, Conn.; Manheim, Pa.;
No. Charleston, S.C.; Passaic, N.J.

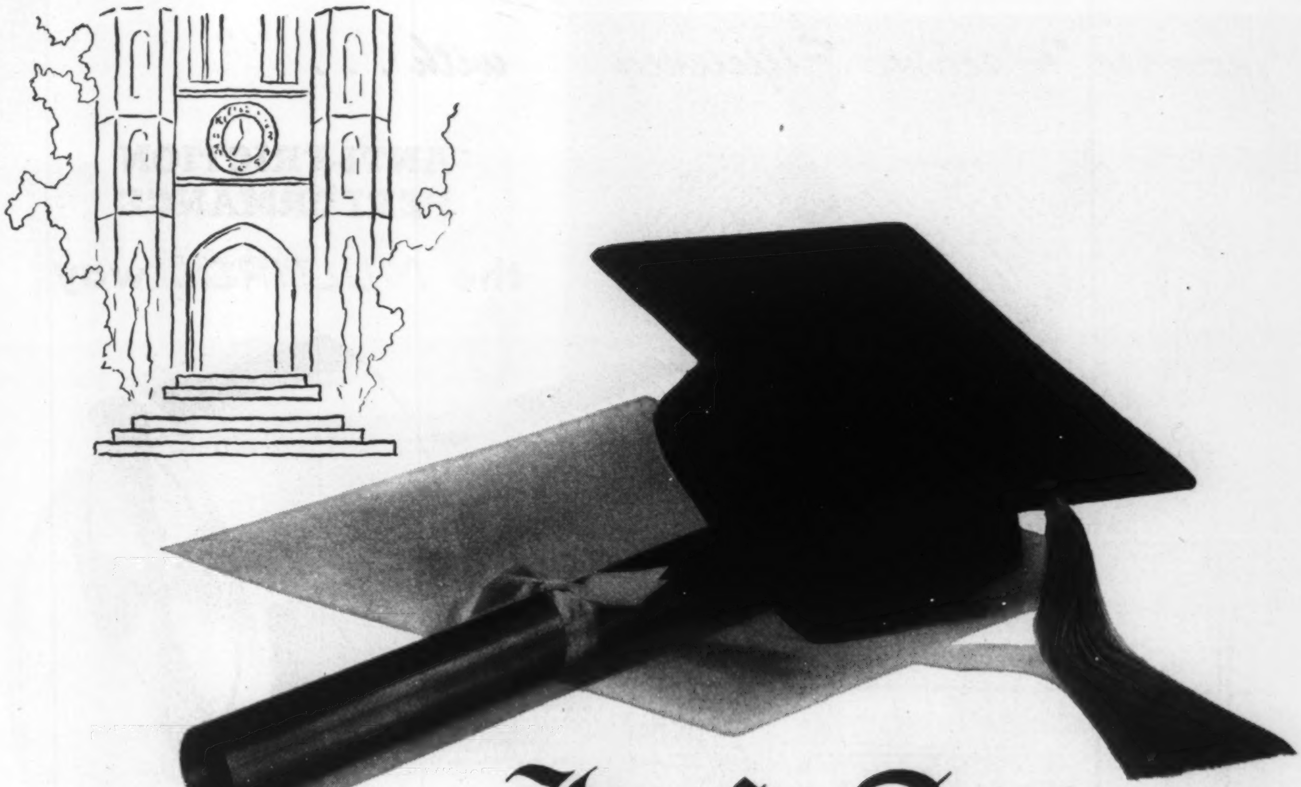
RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Powdered Metal Products • Bowling Balls

RAYBESTOS-MANHATTAN, INC. MD6-49
Packing Division, Manheim, Pa.

Gentlemen: ☐ Please send me a free copy of the R/M Vee-Flex Bulletin.
☐ Please send me a free copy of the R/M Packing Catalog.

Name
Position
Company
Address
City Zone State

R/M



High Aptitude

Things, like humans, can have degrees of fitness—which enable a person to evaluate their worth in relation to the performance they can deliver.

Wolverine tube has proved its high aptitude again and again in such fields as refrigeration and air conditioning; heating and ventilating; laundry and dry cleaning, processing, power and utilities, automotive and aircraft.

May we suggest that you make it a point to turn to Wolverine next time you are about to order tubing.

Wolverine can supply seamless, non-ferrous tubing in any standard size and length, as well as to special specifications.

We welcome your inquiries.

WOLVERINE TUBE DIVISION
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
INCORPORATED
MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING
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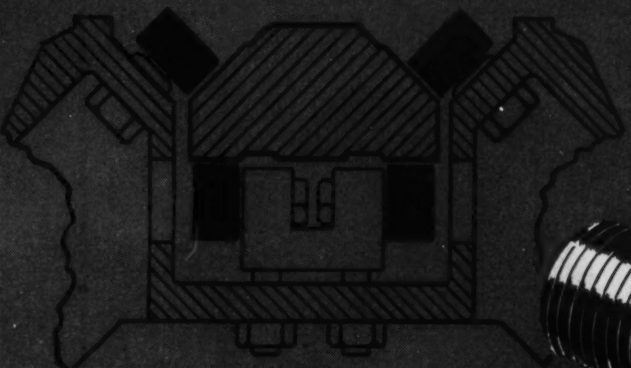
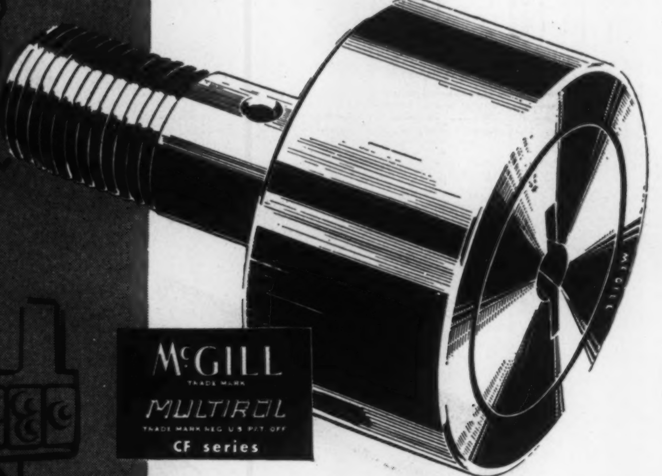
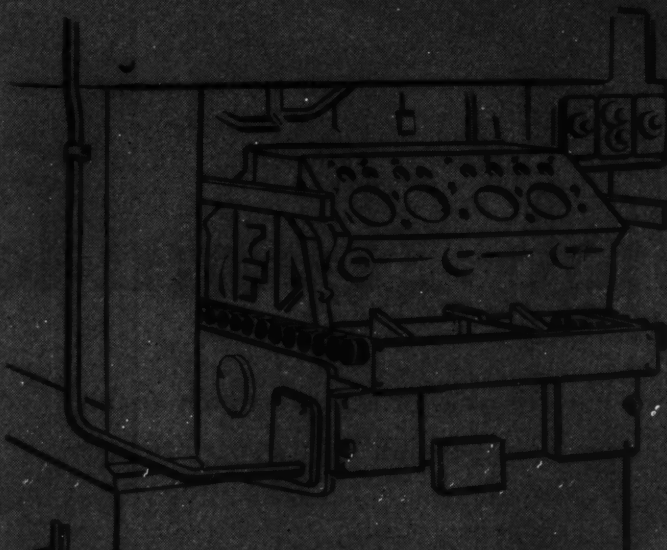
the *MULTIROL* way

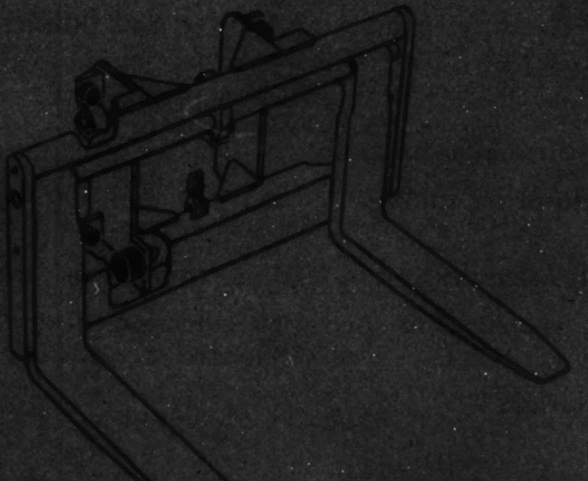


MULTIROL CF Series Bearings as support rollers for oscillating heads and tables on machine tools. Saves costly grinding and scraping of ways.





MULTIROL CF Series Bearings used as conveyor rolls on transfer machines. Precision construction of CF bearings permit accurate machining of parts passing across rolls.



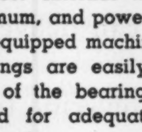
MULTIROL CF Series Bearings as mast and platform guide rollers on lift trucks. Eases lifting and side adjustment of heavier loaded platforms.

When your design goal is the ulumate in anti-friction performance . . . when your specifications include heavier static and shock load capacity . . . then MULTIROL Cam Follower (CF series) bearings are what you've been looking for.

The Cam Follower is a rugged bearing. An extra heavy outer race section stands the repeated shock of cam operation. A full complement of small diameter rollers make up an almost unbroken steel ring which distributes the load evenly over a greater bearing surface. Internal wear and friction are held to the minimum, and power requirements of MULTIROL bearing equipped machines are appreciably lessened. CF bearings are easily lubricated through the stud or face of the bearing and sufficient lubrication is retained for adequate protection of those neglected applications.

MULTIROL Cam Follower bearings are precision built in a range of twenty-two standard roller diameters from ⅜" to 4". This wide variety eliminates the need for special cam follower specifications in most machine design.

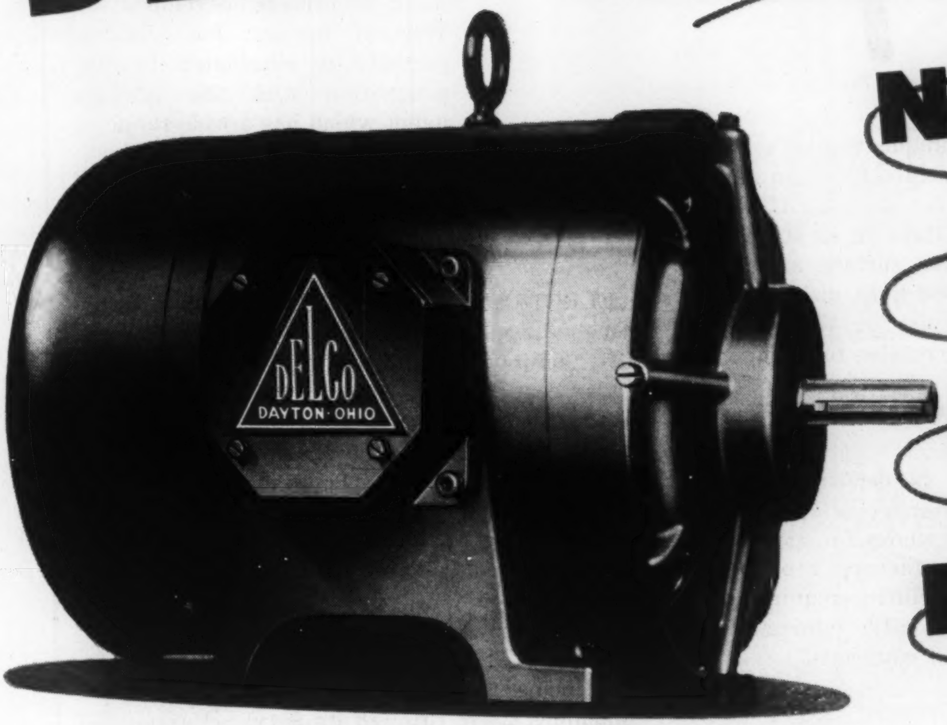
For dependable and long lasting anti-friction applications, at lower cost, investigate MULTIROL CF series bearings. Ask our engineers for their recommendations.



Write for Bulletin CF-40A. McGILL Manufacturing Company, Inc., 200 North Lafayette Street, Valparaiso, Indiana.

McGILL
TRADE MARK
precision bearings

DELCO MOTORS



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Delco polyphase motors, totally enclosed and fan cooled, are produced in sizes from fractional ratings to 75 h.p.

From both an electrical and a mechanical standpoint, Delco industrial motors are designed and built for continuous *peak performance*—there's no down-time with a Delco. The truth of this statement will be apparent to anyone making a unit-by-unit examination of a Delco and discovering among its components such engineering advancements as a double-shell, corrosive-resistant, cast-iron frame; Delcote-insulated coils; unit-cast rotor and shaft, dynamically balanced; positioned bearings; simplified lubrication; water-tight conduit box. It is *plus values* such as these which help to explain why Delco motors stand up to their jobs—why they operate *at less cost* for a *longer period of service*. You can depend on Delco for motors that are RIGHT for your individual jobs.

For complete information on Delco motors write Delco Products, Dayton, Ohio, or call our nearest sales office.

DELCO MOTORS

DELCO PRODUCTS, DIVISION OF GENERAL MOTORS CORPORATION

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Topics

PLASTIC-REPLICA technique, similar to that in use for evaluating surface finish on metal parts, has been developed for studying the texture of porcelain enamel. Haze on an ethyl cellulose replica of the enamel surface measured with transmitted or reflected light discloses details seen only with difficulty on the original surface. These replicas serve also for comparative and record purposes.

TOOL ENGINEERING as defined in Webster's New Collegiate Dictionary is "A branch of engineering in industry whose function is to plan the processes of manufacture, supply the tools, and integrate the facilities required for producing given products with minimal expenditure of time, labor and materials."

HAVING ONLY seven per cent of the world's population, the United States uses 70 per cent of all the oil produced on the globe and 50 per cent of the minerals, according to James Boyd, director of the U. S. Bureau of Mines. In addition the United States does 40 per cent of the world's work through the use of energy obtained largely from mineral fuels.

COSTLY RESTRICTIONS suffered by many industries from out-of-date and nonuniform local regulations have caused the American Standards Association to publish a booklet on the subject, hoping that it may inspire solutions to the problem.

CEMENT for joining glass bulb and metal base of lamps for use at high temperatures has been developed by Westinghouse, replacing the previous mechanical base. Tests show that cement will not deteriorate at temperatures as high as 446 F.

BONDING glass, neoprene, and plastics to metal as well as bonding steel inserts in aluminum, aluminum to aluminum, and brass to aluminum is accomplished in a new batch immersion process developed by Western Sealant Inc. Microporosity is eliminated by impregnation with the bonding agent which has a wide range of resistance to operational temperatures and chemical solvents. Finished parts show no signs of treatment.

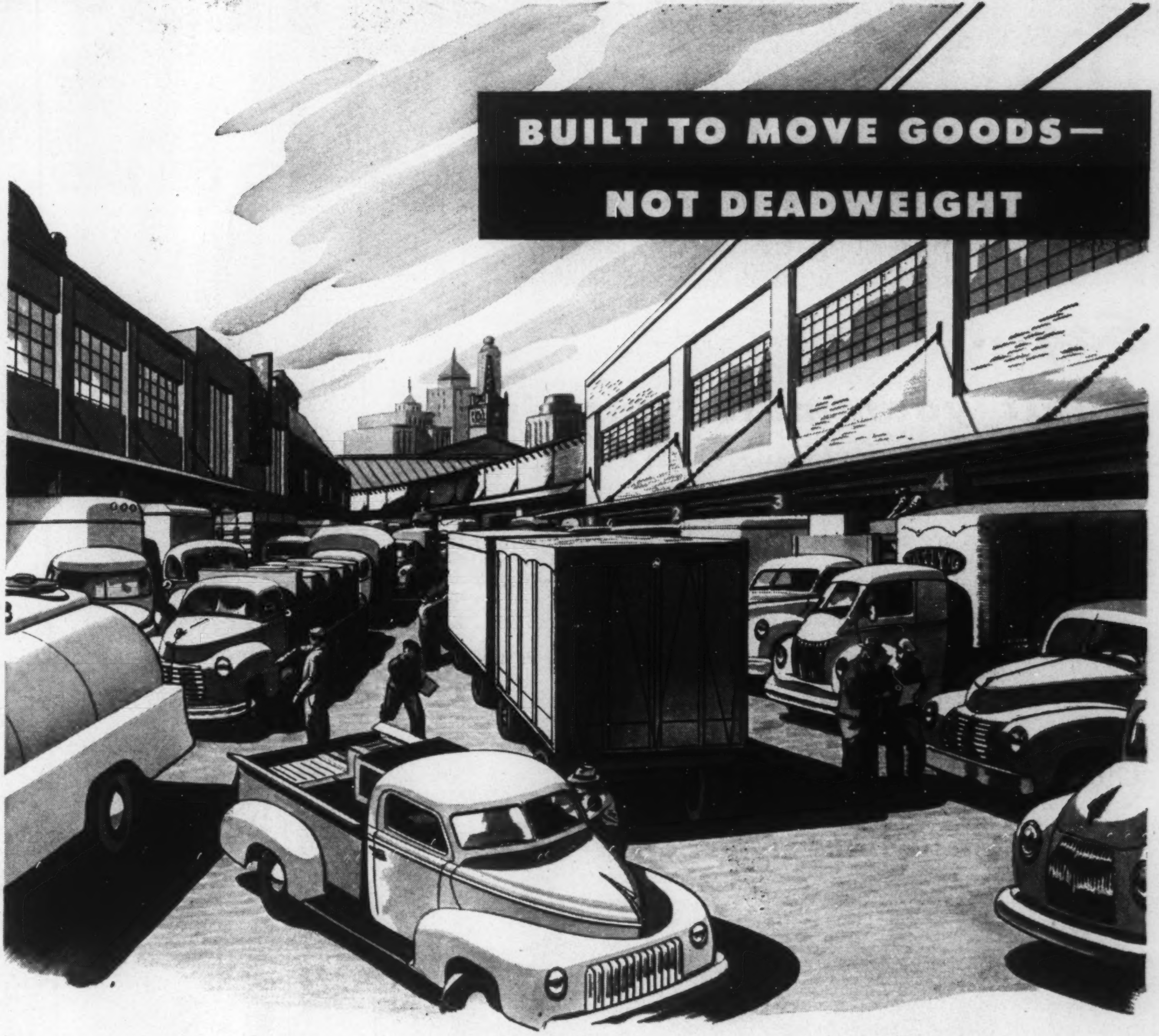
ELECTRONIC EQUIPMENT added to the long-range surveillance radar used in the Berlin airlift facilitated traffic control by providing a radar scope picture of only moving targets, or aircraft. It eliminates all ground clutter composed of a collection of radar pips which normally would represent buildings, trees, mountains and other stationary objects, making it simple to follow the course of incoming aircraft from a distance of 100 miles.

SOLUTIONS to technical computations are now being furnished by International Business Machines Corp. through its Service Bureau, 590 Madison Ave., New York. Calculation of stresses, evaluation of flutter frequencies, application of statistical methods and calculation of efficiencies can be computed readily on IBM's selective sequence electronic calculator or standard electronic and electric machines.

ZIPPERS fasten together rubber diaphragms where the cars are coupled in the new articulated American Talgo railroad train built by American Car and Foundry Co. Fabricated of sheet and sponge rubber, these members present a smooth outer surface throughout the length of the train. A second diaphragm forms the inner wall. Each coach has only one pair of wheels in the rear, serving as the pivot for the coach following.

CHANGEOVER from the 1935 screw thread standards to the new unified 2A and 2B tolerances should proceed as rapidly as transition can be effected, inspection being governed accordingly. The Committee on Standardization recommends, in addition, that for the time being neither the new nor the old classes should be mandatory except for specific applications agreed upon by consumer and producer.

BUILT TO MOVE GOODS— NOT DEADWEIGHT



The weight's in the load and not in the truck when frames, body panels, fenders, wheels and other truck structural parts are made of N-A-X HIGH-TENSILE. And while affording weight savings of up to 25% in section, the high physical properties of N-A-X HIGH-TENSILE insure superior strength and increased resistance to fatigue, corrosion, abrasion and denting.

This decrease in deadweight decreases on-the-job expenses, too. Trucks built with N-A-X HIGH-TENSILE consume less gasoline . . . require less maintenance . . . give longer service. And the excellent formability, weldability, and fine surface texture of N-A-X HIGH-TENSILE mean that you build them better, with no added fabricating problems.

MAKE A TON OF SHEET STEEL GO FARTHER

Specify—

N·A·X

HIGH-TENSILE STEEL

GREAT LAKES STEEL CORPORATION

N-A-X ALLOY DIVISION • DETROIT 18, MICHIGAN
Unit of National Steel Corporation

Say...

you left your motor running!

Do you run your motor 24 hours a day, every day? That's all right, if it's a Fairbanks-Morse motor, you can leave it on the job and forget about it. Fairbanks-Morse motors are built to take on the toughest assignments, to give the finest, trouble-free service. They require minimum attention . . . they assure lowest maintenance costs. Complete information about the full line of Fairbanks-Morse electric motors is contained in the handy POCKET PANORAMA. Write to Fairbanks, Morse & Co., Chicago 5, Ill.

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A name worth remembering

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PUMPS • RAILROAD MOTOR CARS and STANDPIPES • FARM EQUIPMENT • MAGNETOS

JUNE, 1949

MACHINE DESIGN
A PENTON PUBLICATION

A Double Standard?

ASK ANY MACHINE designer the simple question, Does your product meet the needs for which it was designed? Chances are he will act insulted that anyone should question the quality of his work. But what about the quality of the drawings and specifications which the engineering department issues? Certainly many working drawings are far from eye-appealing and not a few are downright sloppy. More important is the amount of reading between the lines necessary to make the drawings fulfill their function of yielding essential information.

More often than not the user of a drawing must attempt to supply missing information, or try to interpret information given in a vague fashion, or must even go back to the source for data needed to make the drawing complete. It must be a strange mental quirk that permits a competent engineer to tolerate a double standard of quality—a high one for his design and a low one for the drawings which depict it.

Just as handbooks and standards are needed to complete a design, so are signposts and standards required in the execution of an acceptable drawing. A comprehensive drafting standard, if universally recognized and adopted, would go far toward insuring drawings that would be uniform in style, complete and specific. Consequent elimination of lost time in interpretation, costly errors in production, etc., would result in substantial dollars-and-cents savings that would more than pay for the slight extra effort required to make such drawings.

As fully discussed in the leading article of this issue, earnest attempts are being made to promulgate a national drafting standard that will be adaptable to all industries. The committees engaged in this work merit the wholehearted support of every engineer in their arduous task.

Through their professional and technical societies, through their companies, and as individuals, engineers can exert a powerful influence. They should lose no opportunity to use that influence in urging early completion and adoption of the new standard, as well as the incorporation in that standard of the best engineering principles and production practices.

Colin Carmichael

EDITOR

Needed— Nation-Wide Drafting Standards

By John G. Perrin

Consulting Engineer
Springfield, Mass.

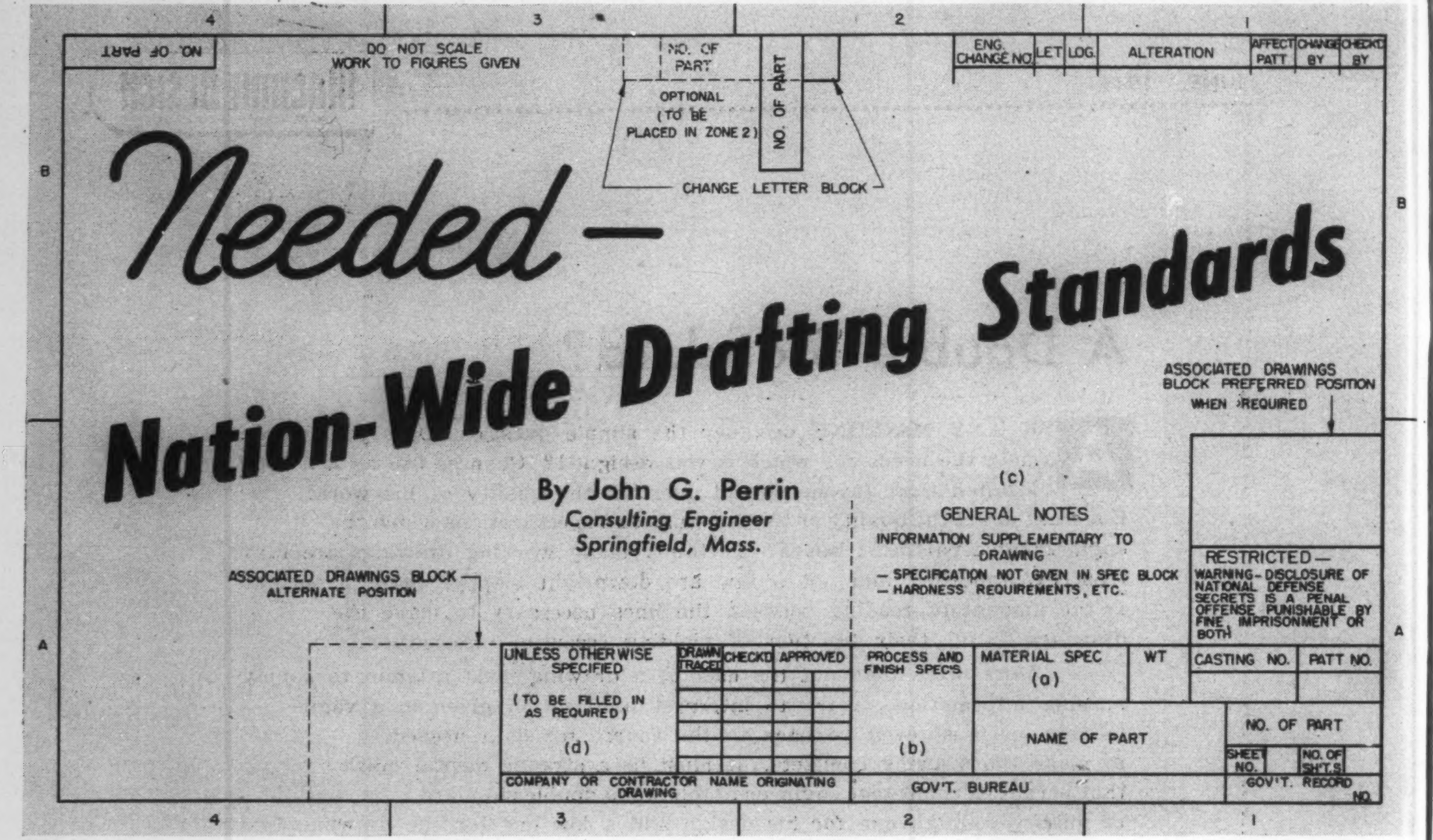

4
3
2
1
NO. OF PART
DO NOT SCALE WORK TO FIGURES GIVEN
NO. OF PART
OPTIONAL (TO BE PLACED IN ZONE 2)
NO. OF PART
CHANGE LETTER BLOCK
ENG. CHANGE NO.
LET
LOG.
ALTERATION
AFFECT PATT
CHANGE BY
CHECKD BY
B
ASSOCIATED DRAWINGS BLOCK PREFERRED POSITION WHEN REQUIRED
(c)
GENERAL NOTES
INFORMATION SUPPLEMENTARY TO DRAWING
– SPECIFICATION NOT GIVEN IN SPEC BLOCK
– HARDNESS REQUIREMENTS, ETC.
ASSOCIATED DRAWINGS BLOCK ALTERNATE POSITION
RESTRICTED—
WARNING- DISCLOSURE OF NATIONAL DEFENSE SECRETS IS A PENAL OFFENSE PUNISHABLE BY FINE, IMPRISONMENT OR BOTH
A
UNLESS OTHERWISE SPECIFIED (TO BE FILLED IN AS REQUIRED)
(d)
DRAWN TRACED
CHECKD
APPROVED
PROCESS AND FINISH SPEC'S
(b)
MATERIAL SPEC
(a)
WT
CASTING NO.
PATT NO.
NAME OF PART
NO. OF PART
SHEET NO.
NO. OF SH'T.S
COMPANY OR CONTRACTOR NAME ORIGINATING DRAWING
GOV'T. BUREAU
GOV'T. RECORD NO.

Fig. 1—Top—Important part of drafting standardization program is development of drawing format which will facilitate rendering of completely informative drawings. This recommended 11 by 17-inch format resolves and combines the best thinking of many drafting authorities

EXPENDITURES for all military needs in 1945 amounted to 80 billions of dollars, and of this amount 70 per cent was spent for mechanical materiel. It is obvious that any means which could speed the procurement of such items merits serious consideration.

Speed of starting and completing war materiel production depends upon the clarity of drawings and the completeness of the information they present. In view of this fact, the importance of a common language of easy interpretation to thousands of subcontractors that are suddenly confronted with blueprints and production orders for parts subject to rigid inspection becomes readily apparent.

In the early part of 1941 the Office of Production Management (later known as the War Production Board) realized the importance of standardization and, as air power was number one in importance, issued orders for the aeronautical industry to standardize its parts and practices as much and as soon as possible. The SAE was designated co-ordinator.

One phase of this program was the order to standardize the drafting practice of airplane engine producing companies. A committee was formed, of which the author was chairman, consisting of the drafting supervisors of the various engine companies. An Airplane Engine Drafting Room Manual (later to be enlarged to Aeronautical Drafting Manual[1]) and standardized practices were agreed upon, greatly facilitating preparation of adequate drawings.

Another notable instance of recognition of the need for drafting standards was the action of the Secre-

HERE ARE THE FACTS about one of the most vital needs in engineering today—a specific, universal graphical language. In a field which is prideful of its ability to deal in facts, the vague, nonfactual specifications on many of our drawings stand out as sheer paradox. What can we do about it? An official nation-wide drafting standard may not be available for years. In the meantime, however, the practices outlined in this timely article can result in substantial savings in both design engineering and production tary of War and Secretary of Navy early in 1946. Directions were issued to their respective departments to unify their drafting practices. The officers designated for this work realized that full effectiveness of such a unification program could not be realized unless the practices of the military services were co-ordinated with those of industry. A War Committee was formed in which industry was asked to co-operate with the Army and Navy. This program proceeded auspiciously for several months, but stagnated due to disorganization of the military and industry when VJ day arrived.

---

[1] References are listed numerically at end of article.

During the early days of the last war, the aeronautical industry experienced considerable difficulty because of inadequate drawings. While these drawings had been satisfactory for centralized manufacturing, when placed in the hands of thousands of subcontractors they made necessary numerous explanations and engineering changes to achieve interchangeability of parts.

It was found necessary to develop a type of drawing in which every dimension and functional surface was adequately toleranced as to size and geometrical relationship. The result was that subcontractors at a distance could develop their tools and gages and inspection practices to produce interchangeable parts without time-consuming telephone calls and visits to the originators of the drawings to get an exact picture of what was required.

There are three levels of drafting practice standardization in progress at the present time.

1. An inter-industry form being undertaken by committees of ASA, ASME and SAE
2. An intra-government Joint Army-Navy (JAN) committee working on uniform practices for drawings made by bureaus of the armed forces. (This is a continuation, by Military Bureaus acting independently, of the ASA War Committee Activities[2])
3. An ABC (American-British-Canadian) standardizing activity started at the Ottawa Conference in September, 1945. This is the attempt to obtain International Drafting Practice Standardization and it is the ultimate goal for all efforts in this line, as in time of war there is a considerable interchange of drawings between these three nations. This effort is being continued at the present time by ASA committee Z14 in this country and by British Standards Inter-Services Committees.

Of these three different activities, the third has called attention to the most important need of standization, i.e., the need of drawing practices insuring interchangeability of components by size and positional tolerances.

Unification Program Under Way

After a year's agitation a project has been undertaken by ASME and ASA to unify these individual efforts. We cannot hope for completion of this work for at least two years unless another war emergency causes the government to crystalize action. In the meantime, in the following pages of this article is given a summary of what has been accomplished by committees working on the problem, as well as an outline of drawing practices found necessary by large prime contractors for Army and Navy equipment during the recent war.

In the only attempt to develop a unified drafting practice between Army, Navy and Industry in early 1945, the meetings in Washington resulted in selection of the following features and items in the composition of a drawing in which it was most desirable to obtain uniformity:

1. Formats
2. General drawing practice
3. Abbreviations
4. Materials and method of specifying
5. Dimensioning for interchangeable manufacturing.

Format (Size, title block and standard information): Difference in size of sheets, title block and methods of conveying standard information was a source of much confusion in filing and keeping records during the war period. A format was tenta-

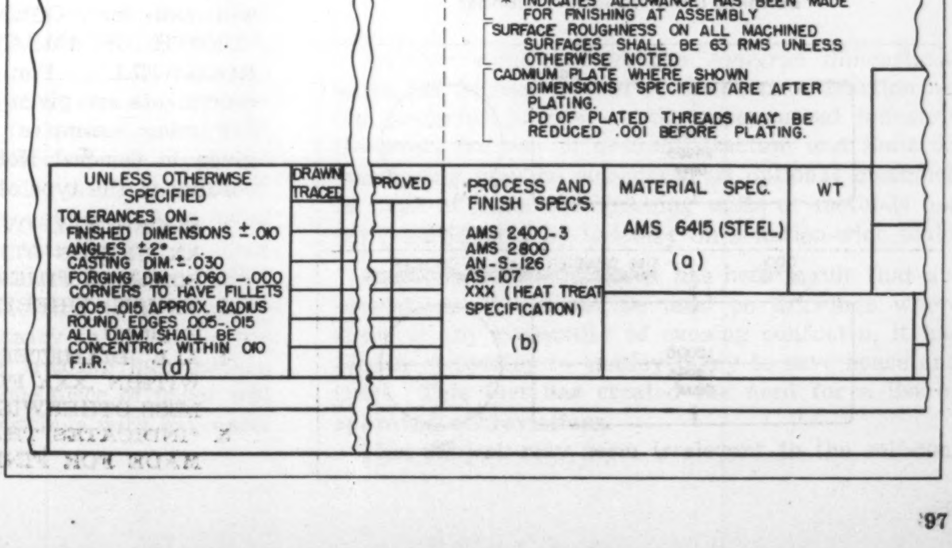

(c)
HARDNESS ROCKWELL 35-40 (OR EQUIV.)
* INDICATES ALLOWANCE HAS BEEN MADE FOR FINISHING AT ASSEMBLY
SURFACE ROUGHNESS ON ALL MACHINED SURFACES SHALL BE 63 RMS UNLESS OTHERWISE NOTED
CADMIUM PLATE WHERE SHOWN DIMENSIONS SPECIFIED ARE AFTER PLATING.
PD OF PLATED THREADS MAY BE REDUCED .001 BEFORE PLATING.
UNLESS OTHERWISE SPECIFIED
TOLERANCES ON-
FINISHED DIMENSIONS ±.010
ANGLES ±2°
CASTING DIM.±.030
FORGING DIM. +.060 -.000
CORNERS TO HAVE FILLETS .005-.015 APPROX. RADIUS
ROUND EDGES .005-.015
ALL DIAM. SHALL BE CONCENTRIC WITHIN .010 F.I.R.
(d)
DRAWN
TRACED
PROVED
PROCESS AND FINISH SPEC'S.
AMS 2400-3
AMS 2800
AN-S-126
AS-107
XXX (HEAT TREAT SPECIFICATION)
(b)
MATERIAL SPEC.
AMS 6415 (STEEL)
(a)
WT

Fig. 2 — Right — Example of how completely informative data is supplied in the recommended drawing format shown in Fig. 1. All specifications are presented in a manner which will leave no doubts in the minds of all parties concerned as to precisely what is required

tively agreed upon by the ASA War Committee on Drawings and Drafting Practices, while it was active. It covered the following features:

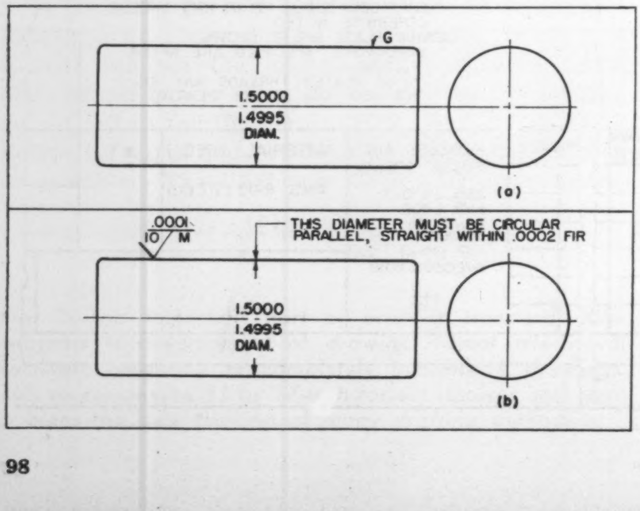
1. An 8½ x 11-inch base size of trimmed sheet and other flat sizes of 11 x 17, 17 x 22, 22 x 34[1, 3, 7]
2. Uniform method of numbering, methods of recording engineering revisions and zoning of same
3. Space for indicating material and any other controlling specifications. These controlling specifications furnish information supplementary to drawing and save time and space on same. In this space hardness requirements also should be given
4. Information required by military bureaus on drawings interchanged between industry and government, such as "Restricted" "Penalties for divulging contents to unauthorized persons", etc.
5. Provisions for recording related drawings (when required).

Contractors for war materiel whose designs originate with government bureaus, have to conform with drawing sizes and formats as well as the drawing practice of the issuing bureau. Because, during the last war there were almost as many sizes and types of drawings as there were bureaus in the services, much confusion was caused to contractors, especially when a prime contractor was working for several bureaus. This illustrates the desirability of government and industry getting together on a standard drafting practice.

Interim Format Recommended

A recommended drawing format is shown in *Fig.* 1, and a detailed working sample is shown in *Fig.* 2. While industry and government's standardizing collaboration is for the time being suspended, this format covers industry's interpretation of the expressed requirement of the military for a format which can be interchanged between an issuing military bureau and an originating industrial munition contractor. It is also suitable for industry's use in peacetime production with the "restricted" or secrecy block and reference to government bureau omitted.

Fig. 3—Specifications of drawing (a) are inadequate; will lead to production of scrap or to wasted time in determining what is required. Drawing (b), of same part, is completely specific; defines all characteristics of part in definite, understandable manner


G
1.5000
1.4995
DIAM.
(a)
.0001
10 M
THIS DIAMETER MUST BE CIRCULAR
PARALLEL, STRAIGHT WITHIN .0002 FIR
1.5000
1.4995
DIAM.
(b)

It is becoming recognized that a production drawing should give complete interpretive information within itself, but subcontracting to distant points has developed the necessity of referring to supplementary specifications so as to give really complete information to production and inspection, and to provide a record by which they can be held legally responsible. For instance, a note in the drawing; "CADMIUM PLATE", requires a background specification which defines the quality and resistance to corrosion required—information too voluminous to put in a drawing and yet absolutely necessary for a satisfactory product.

Provision of blocks Nos. *a, b, c* and *d* (*Figs.* 1 and 2) is the result of studied effort on the part of committees working on this subject to make drawings completely informative. Proper usage of these blocks will insure that adequate information is given to both the production and inspection departments.

MATERIALS—BLOCK (a): In this space is placed the material specification number as well as the material type or classification, such as "STEEL," "MAGNESIUM", "ALUMINUM", "BRASS", etc. In specifying materials, the use, alone, of terms like "BRASS", "CRS", "CAST IRON", etc., should be avoided, especially when the drawing is to be sent to an outside shop. There are numerous compositions of materials covered by each of these general terms, and a distant vendor would surely have to waste time asking for more specific information.

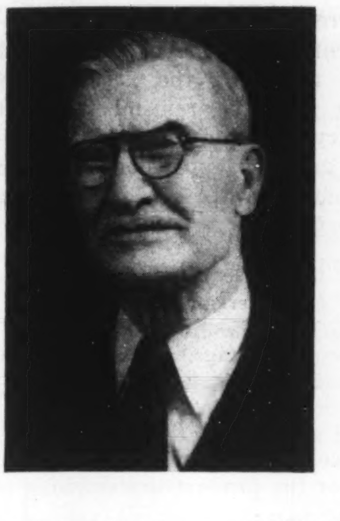
PROCESS AND FINISH SPECIFICATIONS—BLOCK (b): Herein is noted the designating number of any applicable specifications covering the processing (plating, heat treating, testing, inspection, etc.), or finish (surface roughness, etc.).

GENERAL NOTES—BLOCK (c): This space is reserved for any general information applicable to the drawing as a whole as distinct from local notes which are located in close proximity to a section of the drawing to which they apply. Hardness requirements are given by means of Rockwell or Brinell numbers with maximums and minimums. The words "OR EQUIV." are added so conversion values can be used where necessary (for example, when a subcontractor does not possess the type of Rockwell instrument called for). For case-hardened parts, the note will call for "CORE HARDNESS—ROCKWELL", "DEPTH OF CASE", and "CASE HARDNESS—ROCKWELL". For alloy steels, hardenability requirements are given when desired.

Further examples of information which may be given in General Notes follow (these will vary according to the type of industry involved):

1. FINISH ALL OVER—SURFACE ROUGHNESS, XX UNLESS OTHERWISE SPECIFIED
2. SCALE—X TIMES SIZE
3. FINISH WHERE SHOWN (for castings and forgings)
4. ALL DIAMETERS MUST BE CONCENTRIC WITHIN .XXX FIR (full indicator reading), UNLESS OTHERWISE SPECIFIED
5. *INDICATES THAT ALLOWANCE HAS BEEN MADE FOR FINISHING AT ASSEMBLY

Wichita City Library



JOHN G. PERRIN designed and supervised the manufacture of the Lozier racing cars which triumphed in many racing meets of the early 1900's. Inventor of many automotive devices, he has planned and organized factories, supervised the manufacture of engines, organized drafting departments, served as standards engineer, and is at present a consulting engineer as well as a part-time instructor at Trinity College. He has made significant contributions in the standards field as a member of many standardization committees, including those of SAE, ASA, ASEE, and ASME.

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6. DIMENSIONS SPECIFIED ARE AFTER PLATING
7. SHOT PEEN ALL OVER (or except where shown) WITH INTENSITY EQUIVALENT TO .XXX —.XX-XX IN ACCORDANCE WITH SPECIFICATION XXX.

UNLESS OTHERWISE SPECIFIED—BLOCK (d): This block contains tolerances applicable to all dimensions on the drawing except those which require particularly close tolerances or to others where broad tolerances are permissible. It obviates the necessity and cost of repeating the same tolerance on all dimensions.

As has been indicated, all specifications and notes appearing on a drawing should be *specific,* leaving no question in the mind of anyone as to what is being indicated. When calling for materials, standard specifications such as those of ASTM, SAE, AMS, etc., should be used except where a tradenamed material not covered by standards is required. Exemplary, explicit specifications are those appearing in the sample format of *Fig.* 2, which refer to a heat-treated, cadmium-plated, steel part.

In Block (a) of *Fig.* 2, AMS 6415 is an oil-hardening, chromium-nickel-molybdenum steel similar to SAE 4340. In Block (b), AMS-2400-3 is a specification covering inspection requirements for cadmium plating; AMS-2800 is a specification covering a method of marking machined parts for identification; AN-S-126 is an Army-Navy specification for form and quality of straight screw threads; and AS-107 is an SAE specification for surface roughness. Also listed in Block (b) is a heat treating specification to cover methods of obtaining the Rockwell hardness called for in General Notes. By referring to a company specification it will be unnecessary to encumber the drawing with voluminous heat treating information, and in case of a change only one piece of paper will be affected instead of many drawings with expensive engineering changes.

It will be noted that the entries in the blocks of *Fig.* 2 consistently follow Aeronautical and SAE standards. This is because these are the most complete available at the present time. However, other equivalent standards may be substituted according to the type of industry in which the company originating the drawing is engaged. For example:

SAE 4340 may be substituted for AMS 6415
ASTM A165-40T may be substituted for AMS-2400-3
ASA-B46 may be substituted for AS-107
Federal Spec. H28 may be substituted for AN-S-126

GENERAL DRAWING PRACTICE: The practices outlined in the *Aeronautical Drafting Manual*[1] and the *Drafting Room Manual of the Air Techical Service Command*[3] represent the collaboration of the aeronautical and automobile industries as producers, and the Air Force as user, of the largest amount of military equipment. They are the nearest approach to an industrial standard for general drafting practice, and embody a number of variations from the orthodox textbooks on engineering drawing; some minor, others major.

For example, the old cutting-plane line has been changed from a series of one long and two short dashes to a series of heavy long dashes. In wartime standardizing the fact was brought out that many large companies were using the new line as it was quicker to make on large drawings. Another change concerns the "alternate position" line which comprised a broken line made up of long dashes. It has been changed to a "phantom line" comprising a series of one long and two short dashes of medium weight. This change was instigated by the Army Air Force, which had considerable use for an intangible (phantom) line in aircraft envelope drawings, etc. It is also applicable for use in representing a simplified screw thread.

Use of the "unidirectional" or horizontal method of noting dimensions instead of the "aligned" system is preferred practice in these two manuals and has been adopted by the majority of high-production manufacturers. Use of *limits* to express tolerances instead of a basic size with bilateral or unilateral tolerances is noted as preferred practice among large users of gages with fixed limits.

Dimensional Units Optional

Another significant change concerns dimensional units, the decimal instead of the common fraction being preferred practice in the aeronautical industry. However, the use of decimal, fraction and limit dimensioning may be considered as optional inasmuch as none of these dimensioning units or methods has yet been adopted by industry on a nation-wide scale.

ABBREVIATIONS: While it has been a rule that abbreviations should not be used on drawings where there is any possibility of causing confusion, it has become necessary to employ many to save space and time. This fact has created the need for a list of approved abbreviations.

This subject may seem irrelevant to the self-contained organization, but to companies receiving orders and drawings from other companies or from many bureaus of the government, duplication of abbreviations with different meanings has caused much confusion. During the activities of the War Committee, 7000 abbreviations in use by government bureaus and industry were boiled down to less than 3000. The best list of abbreviations and symbols immediately available to industry are those contained in the Aeronautical Drafting Manual[1] and consists of approximately 300.

Dimensioning for Interchangeable Manufacturing: This is the most important element of uniform drafting standardization, even outranking the desirability of uniform formats. What is required is the adequate tolerancing of size and geometrical position of all surfaces on a component so that tool and gage makers and inspectors will have a clear picture of designers' requirements. When this information is on a drawing, it is a permanent record and saves many manhours of recurrent questioning.

RECOMMENDED MATERIALS SPECIFICATIONS

Aeronautical Material Specifications (AMS)

Published by Society of Automotive Engineers, Inc., 29 W. 39th St., N. Y. 15. A compilation of materials and complete procurement specifications developed for the aeronautical industry's requirements. Also a list of processes with inspection requirements used in the aeronautical industry. In many cases these specifications are more rigid than is considered necessary for more general purposes. The AMS is the aeronautical industry's effort to give equivalents in a standardized form, of the Army, Navy and Federal Specifications for materials and processes.

SAE Handbook

Published by Society of Automotive Engineers, Inc., 29 W. 39th St., N. Y. 15. A list of steel compositions as well as other processed materials published in SAE Handbook of standards. Heat treatments used to obtain desired physicals are also given in this handbook. Used in almost all branches of mechanical engineering, both in America and abroad.

AISI Steel Products Manuals

Published by American Iron and Steel Institute, 350 Fifth Ave., N. Y. 1. These designations for steel compositions, with numbers paralleling those of SAE but with allowances on composition analyses to facilitate procurement during war emergency, were originally developed in 1941 through collaboration of SAE as users and AISI as producers. Almost all SAE steels are now AISI standard steels. The former National Emergency (NE) steels, brought out during the last war, have been absorbed in the SAE and AISI lists.

ASTM Standards

Published by American Society for Testing Materials, 1916 Race St., Phila. 3. This compilation consists of specifications, definitions and methods of test for all types of engineering materials.

Following are comments from one of the largest airplane manufacturers regarding the necessity of adequate drawings. It must be remembered that the aeronautical industry, (aircraft as well as engine) experienced the greatest expansion and had the largest set of subcontractors of any industry on which our war effort depended:

> "Personally we would like to see some (universal) manual devote time to controversial points such as tolerances, concentricity, etc. For example, if we omitted tolerances on our drawings, as is done by some concerns, parts made by outside vendors would not fit at all."

Companies doing subcontracting in peacetime will find a lowering in costs of the product if a drawing is made as to leave nothing to guesswork. A vendor is not impelled to make a part costlier than necessary in order to "play safe" if he is given a drawing with complete tolerances for production and inspection. He will also save the cost of seeking information.

It may be said that such drawings cost more in draftsmen's time. That is true, and for a shop where a drawing doesn't circulate outside of the room or building in which it originated it may be thought an unnecessary cost. The fact is that even where a drawing is used in various departments of only a small factory, if it is to be used for a period of time, the *invisible* cost to operations directly traceable to a drawing which is not completely informative more than offsets the time employed in making it a really complete permanent record. Time consumed by telephone calls and in trips to the drafting room by tool engineers, production and inspection personnel, etc., for interpretation and decisions is an invisible cost often disregarded in the past under the naive assumption that it constituted normal practice.

Recommended Drafting Practices for Production ~~of~~ Interchangeable Components: In the absence of any national industrial or government manual outlining a drafting practice insuring the manufacture of interchangeable parts, it would be well for all designers and draftsmen to familiarize themselves with the principles described in the following:

"Principles of Interchangeable Manufacture"[4]
"Engineering Problems in Dimensions and Tolerances"[5]
"Drafting Office Practice in Relation to Interchangeable Components"[6]

Every dimension on a drawing (and permissible deviation from correct geometrical position) should be toleranced by one of the following methods:

1. Individually
2. By a title-block standard "unless otherwise specified", etc.
3. By a shop standard of workmanship which should accompany the drawing when it is sent to a new outside supplier.

The following relationships of *functional* surfaces require statements of fact regarding their permissible deviation from exact geometry so that drawings can be interpreted successfully for interchangeability.

Tolerances should be based on what is *permitted*, rather than on what is *desired:*

1. Flatness (of a surface)
2. Straightness (of lines and holes; also an element of flatness)
3. Parallelism (of axes or surfaces)
4. Alignment (of holes and surfaces)
5. Squareness (of holes or surfaces)
6. Roundness (of holes, cylindrical shapes, etc.)
7. Concentricity (of holes or cylinders)
8. Symmetry (centrality—relation of keyways, dowel holes, etc., to centerline or functional surface)
9. Profile dimensioning. All dimensions determining contour should be without tolerances, defining a datum line from which a tolerance is given establishing a *zone of tolerance* (this avoids conflicting tolerances)
10. Hole patterns. These should be dimensioned by co-ordinates accompanied by tolerances. Value of tolerances will depend on whether holes are functional or nonfunctional
11. Surface roughness. "How smooth is smooth?" Give the answer where necessary in microinches, etc. (see AS-107 or ASA-B46). Avoid use of "grind" for a fine surface. A fine grind may vary from 5 to 50 microinches in surface roughness. Furthermore, "fine" surfaces may be obtained by a variety of methods.

Such unqualified statements as: "This surface must be flat", "These surfaces must be square with each other", and "These diameters must be concentric with each other", should be avoided because they are not specific. They do not indicate *how* flat, *how* square, or *how* concentric. They are confusing to the shop outside of the originator of the drawing and lead to the making of scrap if the operator interprets them too carelessly, or, if he plays safe and makes the part better than is actually necessary, the part will be excessively expensive.

Fig. 3*a* is a good example of a drawing which, if sent to distant subcontractors, would lead to fabrication of inacceptable work or to considerable wasted

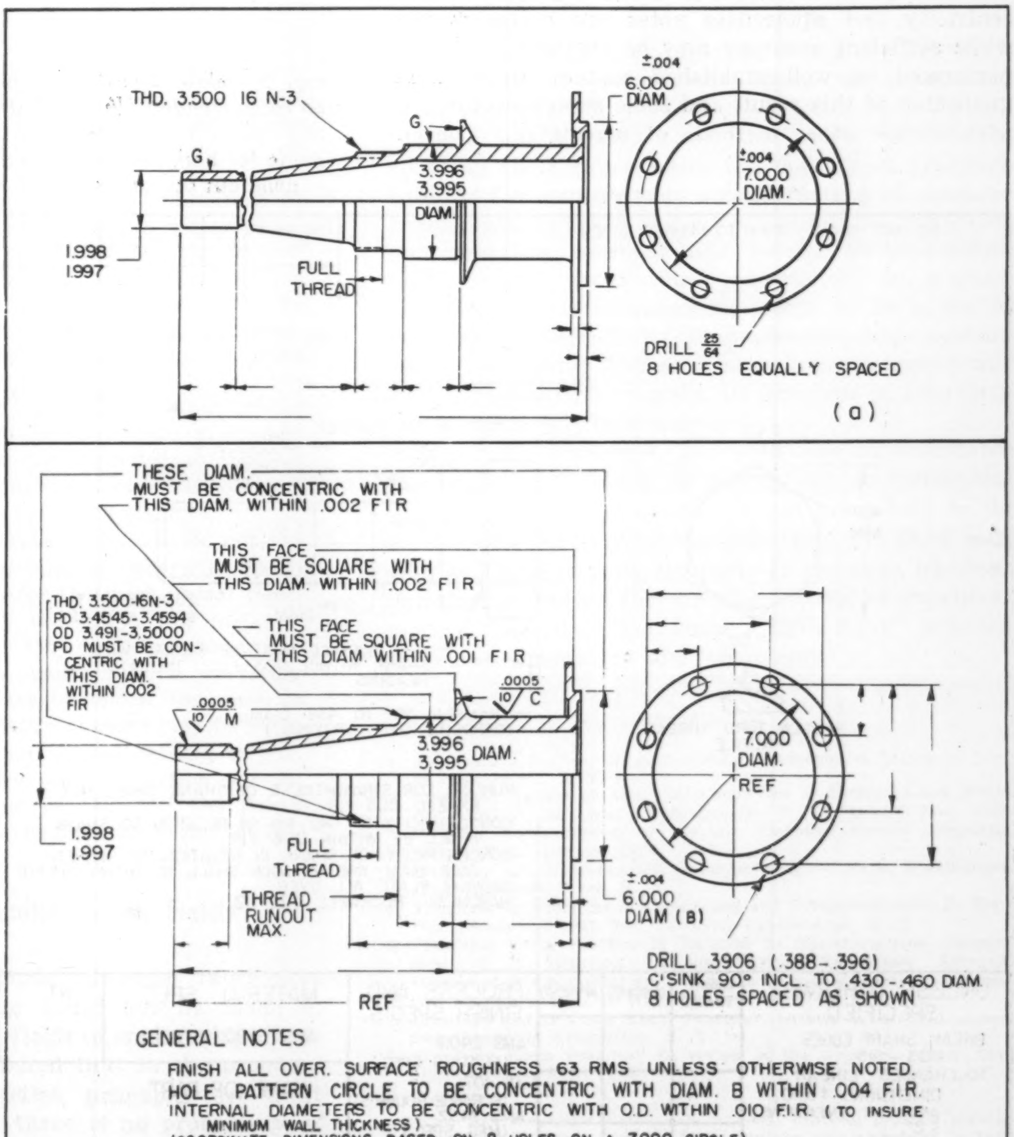

THD. 3.500 16 N-3
G
G
±.004
6.000
DIAM.
±.004
7.000
DIAM.
3.996
3.995
DIAM.
1.998
1.997
FULL
THREAD
DRILL $\frac{25}{64}$
8 HOLES EQUALLY SPACED
(a)
THESE DIAM.
MUST BE CONCENTRIC WITH
THIS DIAM. WITHIN .002 FIR
THIS FACE
MUST BE SQUARE WITH
THIS DIAM. WITHIN .002 FIR
THD. 3.500-16N-3
PD 3.4545-3.4594
OD 3.491-3.5000
PD MUST BE CONCENTRIC WITH
THIS DIAM.
WITHIN .002
FIR
THIS FACE
MUST BE SQUARE WITH
THIS DIAM. WITHIN .001 FIR
.0005
10
M
.0005
10
C
3.996
3.995 DIAM.
7.000
DIAM.
REF
1.998
1.997
FULL
THREAD
THREAD
RUNOUT
MAX.
±.004
6.000
DIAM (B)
DRILL .3906 (.388-.396)
C'SINK 90° INCL. TO .430-.460 DIAM.
8 HOLES SPACED AS SHOWN
REF
GENERAL NOTES
FINISH ALL OVER. SURFACE ROUGHNESS 63 RMS UNLESS OTHERWISE NOTED.
HOLE PATTERN CIRCLE TO BE CONCENTRIC WITH DIAM. B WITHIN .004 F.I.R.
INTERNAL DIAMETERS TO BE CONCENTRIC WITH O.D. WITHIN .010 F.I.R. (TO INSURE MINIMUM WALL THICKNESS)
(COORDINATE DIMENSIONS BASED ON 8 HOLES ON A 7.000 CIRCLE)
(b)

Fig. 4—Drawing at (a) is not sufficiently specific to insure trouble-free interpretation. Drawing at (b) leaves nothing to chance, its completely informative specifications guaranteeing that all parties concerned in production of part will understand, without question, precisely what is required

time in determining exactly what is required. With this piston pin dimensioned as shown, the inspection department could accept a pin 0.0005-inch larger at one end than at the other; a pin out-of-round by 0.0005-inch; or one which could be 0.0005-inch less in diameter at the center than at the ends. Further, the designation "G" (grind) is not definite enough to define surface finish.

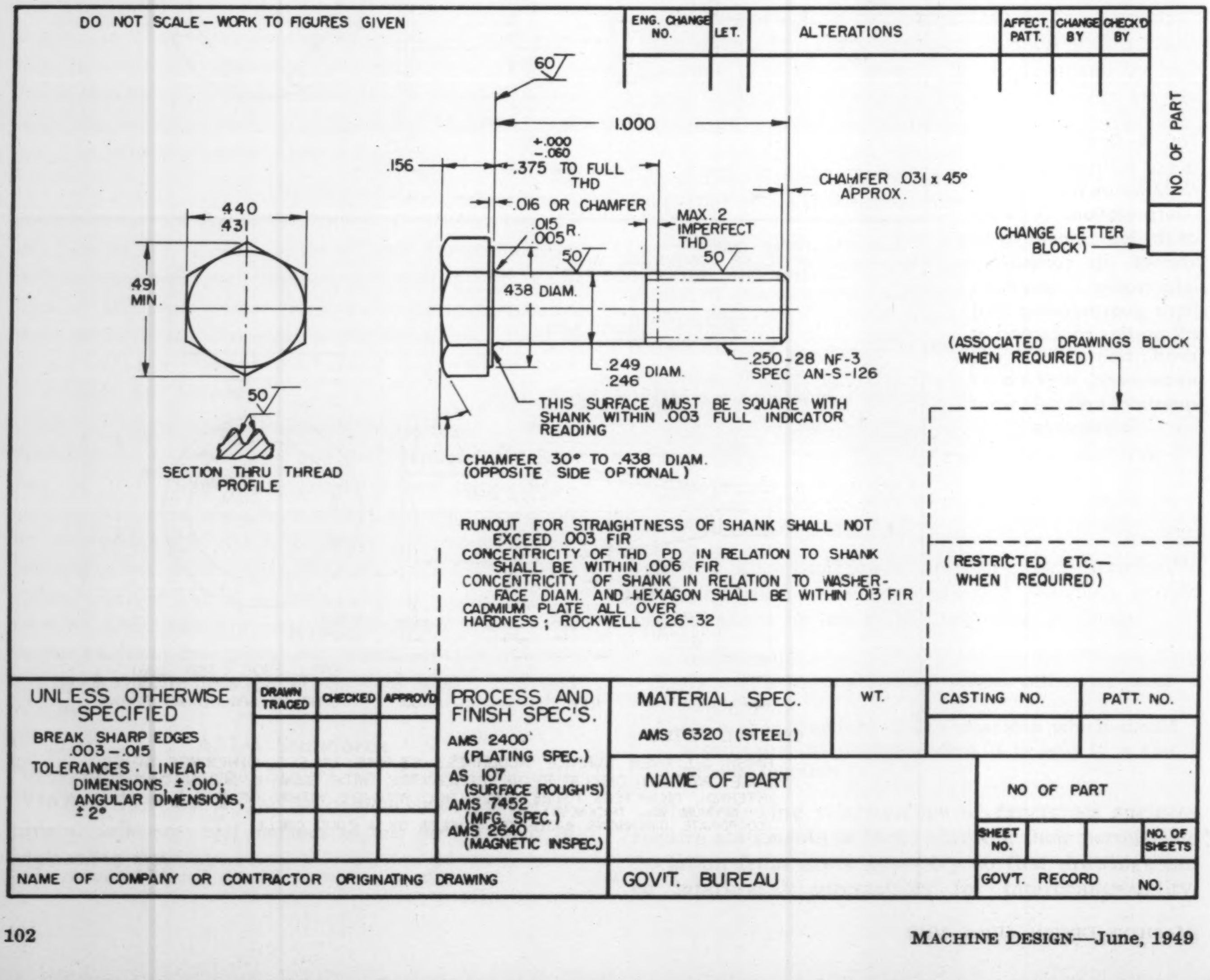
All of these uncertainties might result in a part unsuited for service as a piston pin. Additional, more definite information should be given as in *Fig. 3b,* wherein circularity, parallelism, straightness, and surface finish are specified to definite limits. As regards surface roughness, the designation given indicates a finish of 10 rms in average height of roughness, a waviness height of 0.0001-inch and a multidirectional grain or pattern (Superfinish). In all cases the roughness value specified is the maximum allowable.

Fig. 4a is another example of a drawing not specific enough to insure trouble-free interpretation, while *Fig. 4b* shows a completely specific drawing of the same part. It will be noted in *Fig. 4b* that concentricity and squareness notes are necessary, for while sufficient accuracy may be obtained if work is performed on well-established centers, there is no guarantee of this result and some subcontractor may wish to use other methods of machining. Concentricity between the bolt-hole circle and the pilot diameter, *B,* also is necessary. The thrust face (middle flange) requires a smooth, full bearing and a circular grain (not a "sunburst" pattern) to insure against wear and cutting. All axial dimensions should be based on this surface as a datum.

While the co-ordinate method of dimensioning the hole pattern, as indicated in *Fig. 4b,* is the one preferred by a majority of manufacturers, many leading companies are adopting the "true position" method of dimensioning hole patterns similar to the principle advocated by C. A. Gladman[3], but using notes instead of symbols, i.e., "8 HOLES EQUALLY SPACED AND LOCATED WITHIN .004-INCH OF TRUE POSITION." *True position* might be defined in this case as the intersection of the basic angle (45 degrees) with the hole pattern circle located by the basic diameter.

Amount of thread runout is specified because lack of this information often has caused a lot of questioning. As in the case of the piston pin, surface finish designations are necessary, "G" not being sufficiently specific.

Fig. 5—Below—Drawing of hexagon-head bolt rendered on recommended 8½ by 11 drawing format.. The definite and complete specifications shown serve as a positive guide for both production and inspection personnel. Note generous use of AMS and AS standard specifications


DO NOT SCALE – WORK TO FIGURES GIVEN
ENG. CHANGE NO.
LET.
ALTERATIONS
AFFECT. PATT.
CHANGE BY
CHECK'D BY
NO. OF PART
(CHANGE LETTER BLOCK)
60
1.000
+.000 −.060
.156
.375 TO FULL THD
.016 OR CHAMFER
CHAMFER .031 x 45° APPROX.
.015 .005 R.
MAX. 2 IMPERFECT THD
50
50
.440 .431
.491 MIN.
438 DIAM.
.249 .246 DIAM.
.250-28 NF-3 SPEC AN-S-126
50
SECTION THRU THREAD PROFILE
THIS SURFACE MUST BE SQUARE WITH SHANK WITHIN .003 FULL INDICATOR READING
CHAMFER 30° TO .438 DIAM. (OPPOSITE SIDE OPTIONAL)
(ASSOCIATED DRAWINGS BLOCK WHEN REQUIRED)
RUNOUT FOR STRAIGHTNESS OF SHANK SHALL NOT EXCEED .003 FIR
CONCENTRICITY OF THD PD IN RELATION TO SHANK SHALL BE WITHIN .006 FIR
CONCENTRICITY OF SHANK IN RELATION TO WASHER-FACE DIAM. AND HEXAGON SHALL BE WITHIN .013 FIR
CADMIUM PLATE ALL OVER
HARDNESS; ROCKWELL C26-32
(RESTRICTED ETC.— WHEN REQUIRED)
UNLESS OTHERWISE SPECIFIED
BREAK SHARP EDGES .003 – .015
TOLERANCES · LINEAR DIMENSIONS, ±.010; ANGULAR DIMENSIONS, ±2°
DRAWN TRACED
CHECKED
APPROV'D
PROCESS AND FINISH SPEC'S.
AMS 2400 (PLATING SPEC.)
AS 107 (SURFACE ROUGH'S)
AMS 7452 (MFG. SPEC.)
AMS 2640 (MAGNETIC INSPEC.)
MATERIAL SPEC.
AMS 6320 (STEEL)
WT.
CASTING NO.
PATT. NO.
NAME OF PART
NO OF PART
SHEET NO.
NO. OF SHEETS
NAME OF COMPANY OR CONTRACTOR ORIGINATING DRAWING
GOV'T. BUREAU
GOV'T. RECORD NO.

A good example of a drawing leaving little doubt as to what is acceptable is that shown in *Fig.* 5. The hexagon-head bolt illustrated is one of a category of parts made in huge quantities during the last war. Note how everything required of the fabricator is indicated in definite, specific terms and, also, that the complete specifications listed will leave no doubts in the mind of fabricator or inspection department as to what will be acceptable. It should be noted, also, that the format on which this drawing is rendered is that of the 8½ x 11-inch size herein recommended.

Miscellaneous recommendations for insuring that drawings will be suitable for subcontracting in quantity production of interchangeable parts follow:

1. Give *end results* rather than the *means* of obtaining them (means is the job of the shop)
2. Avoid terms "Grind", "Ream", etc., which limit the subcontractor in developing his own methods of achieving the required size or finish. Specify instead surface finish in microinches either in general notes or as a specification reference (ASA-B46 or AS-107)
3. Dimension for latitude in inspection and to limits which are readily attainable by normal production means. (It should be realized that tools, jigs, bushings, pilots, etc., wear, resulting in an occasional below-standard grade of product, not actually subject to rejection, however, if drawing tolerances are liberal enough to permit acceptance by the inspection department)
4. Refer, where necessary, to fact that part must fit a master gaging system to insure interchangeability; such gages to be furnished to the subcontractor (splines, for instance, have many possible permissible errors, and while these may be checked individually, the effect of their accumulation on the fit can only be checked by receiving and plug gages)
5. Establish datum surfaces in each plane where needed and run all dimensions from such surfaces. This enables a subcontractor to tool up more intelligently by knowing where the important shoulder or surface is in each plane
6. Tolerance liberally wherever feasible. Do not use a general note such as "Unless Otherwise Specified, plus/minus 0.010" for the most liberal tolerance unless it is really necessary. For instance, an unimportant length may well be plus/minus 0.030 or more. While under normal operating conditions it may be easy to hold a dimension to plus/minus 0.010, a quantity of parts may be made in excess of the plus/minus 0.010, leading to possible proper but unnecessary rejection by an inspector, especially one representing the Army or Navy, who considers the drawing as his "bible".

Standards Applicable to All Fields

The claim has been made by some fabricators that standardized drafting could not be made to apply to all the diversified fields of engineering. However, it should be remembered that in the proposed standardized drafting practice, principles are dealt with and not details, and there is no probability of infringing on the initiative of special practices as regards freedom of design. The following three requirements of a standardized drawing could be fulfilled equally well in the drawing for a machined part or any structure:

1. Uniformity of size and format
2. Uniformity of language used on drawing (approved drawing practice), etc.
3. Dimensional information for part described on drawing adequate for it to be made at a location distant from place where it is assembled with mating part.

These requirements could be met in a drawing of a wheelbarrow, airplane engine part, or the girder of a bridge. The difference would be in degree rather than in principle. The wheelbarrow part would have wide tolerances for size and material, the engine part finer tolerances, and the bridge part tolerance would be covered in a supplementary specification, all of which conditions would be provided for in the standard.

There is nothing untried in the practices outlined and recommended. They are in use in whole or in part by many of the large manufacturing companies which were concerned with extensive subcontracting during the last war, and are incorporated into many of their private drafting manuals. However, as a composite picture, they have never appeared in public print.

There is a growing realization of the economy in adopting these practices in the making of drawings suitable for country-wide subcontracting of machine components in peace or war. Certainly the principles and practices outlined will receive understanding and approval from those experienced in making drawings for interchangeable parts to be made in quantity production by the subcontracting system. Those not having had such revealing experience will find it cost-saving to make all drawings of long-time value, completely informative.

Somebody, sometime, has to decide on acceptable tolerances, etc., which do not appear on incomplete drawings. If the draftsman is not competent to do so, let him get this information from the shop man who will have to make the part. In any case, let these data be entered on the drawing instead of constituting an "unwritten gentlemen's agreement" between shop men, inspectors and assemblers.

References

1. *Aeronautical Drafting Manual,* Society of Automotive Engineers, Inc., 29 West 39 St., N. Y. 15.
2. "Proposed Agenda of ASA War Committee on Drawings and Drawing Practice", *Industrial Standardization,* W. A. Bischoff, June, 1945.
3. *Drafting Room Manual of the Air Technical Service Command,* Wright Field, Dayton, Ohio.
4. *Principles of Interchangeable Manufacturing* — Earle Buckingham, 1920, Industrial Press, N. Y.
5. "Engineering Problems in Dimensions and Tolerances"—W. B. Werring, *Monograph* 1941, Bell Telephone Laboratories, N. Y.
6. "Drafting Office Practice in Relation to Interchangeable Components", C. A. Gladman, National Physical Laboratory, England. (Copies of this pamphlet are obtainable from the Society of Automotive Engineers, Inc., 29 West 39th St., N. Y. 15.)
7. *Drawings and Drafting Room Practice*[*], booklet Z14.1, 1946, American Standards Association, N. Y.
8. "Drafting Room Practice" (a review of the Gladman paper), MACHINE DESIGN, Feb., 1946.

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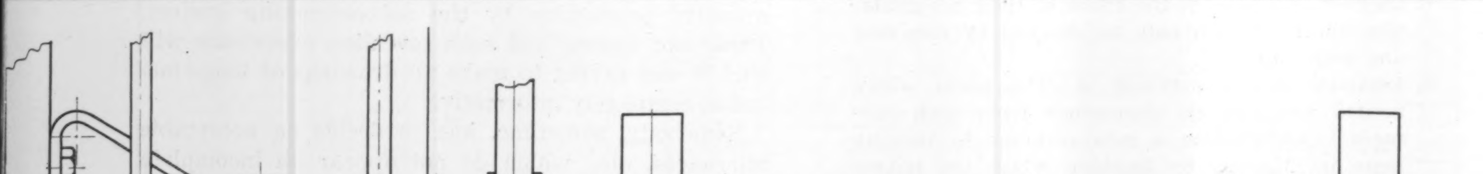
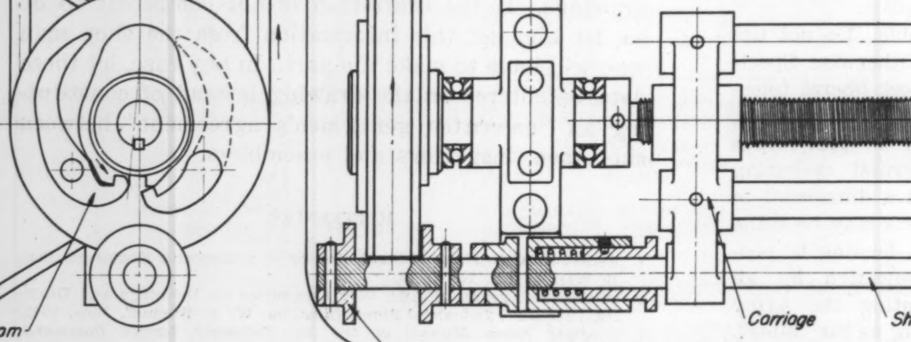
[*] This was the original and only national drafting practice manual for a number of years, but the latest revision was completed in 1943 at a time when the war emergency caused intensified activity toward standardizing drafting room practices among war contractors. References Nos. 1 and 3 are more representative of later and preferred general drawing room practices.

Scanning the field for Ideas

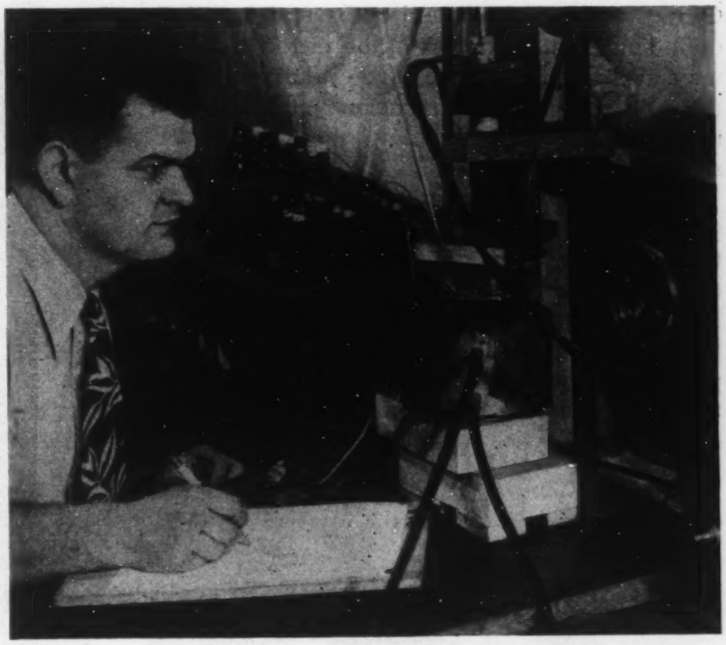
Overrunning clutch, below, was developed for alternate-rotation drive of a portable unit which required a reciprocating motion of its carriage. Cost, space, weight, and maintenance were determining factors for the drive. Hydraulic equipment which normally might be used for this purpose proved too costly.

With the pulley running in the direction indicated by the arrow, a roller is wedged between a rocker and the hub of the clutch. This rocker is held in position by a latch on the lower end of the cam on the left side of the clutch as shown in the end view. In this position the carriage of the unit is moving toward the right. At the end of its travel the carriage contacts a spring-loaded thimble on a shifter bar. A detent on the bar allows it to shift to the right, bringing a trip collar into contact with the driving cam and releasing the rocker. Wedging action crowds the roller, shifting the rocker into a position where it is caught by the latch on the second cam. At the same time a similar trip collar on the other side of the clutch moves





away from its cam. The drive then freewheels until it is reversed and the opposite cycle takes place. This clutch was designed by Harry Bern, Chicago, for operation by a single-phase motor equipped with an inexpensive drum type reversing switch.



Resistance of Materials to destructive action of cavitation is being studied at Allis-Chalmers Manufacturing Co. with accelerated test apparatus illustrated at right. Using a high-frequency oscillator with electronic control, the equipment vibrates specimen materials at a frequency of 6500 cycles per second and amplitude of 0.00342-inch in seeking materials which have high resistance to pitting, are economical, are easy to cast and fabricate, and can be used for repairing pitted surfaces.

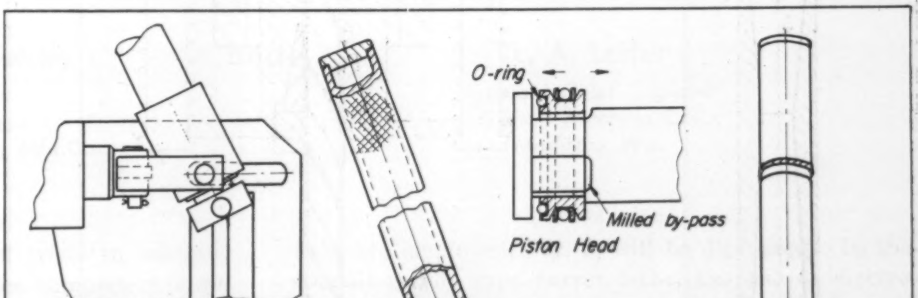
High-speed movies have shown that the voids caused by cavitation form vapor bubbles of the order of 0.3-inch in diameter, have a life of about 0.003-second, and collapse at a maximum rate of 765 feet per second upon the surface on which they are formed. Calculations indicated that this rapid collapse produces a water hammer, causing pressures of at least 50,000 psi on the surface. This hammering results in pitting action on the surface of the material, probably due to fatigue failure.

In the accelerated test a small sample or button of the material to be tested is attached to the end of a nickel rod which vibrates longitudinally in the electronically induced alternating magnetic field. The rod is so positioned that the test specimen is slightly under the surface of a constant-temperature distilled water bath, causing an accelerated formation of cavitation bubbles on the surface of the sample. Weight loss of the specimen during two hours of test, equivalent to years of service, is a measure of the pitting which has taken place.

Among materials tested have been stainless steels, bronzes, sprayed metals, several of the superalloys, and rubber coatings.

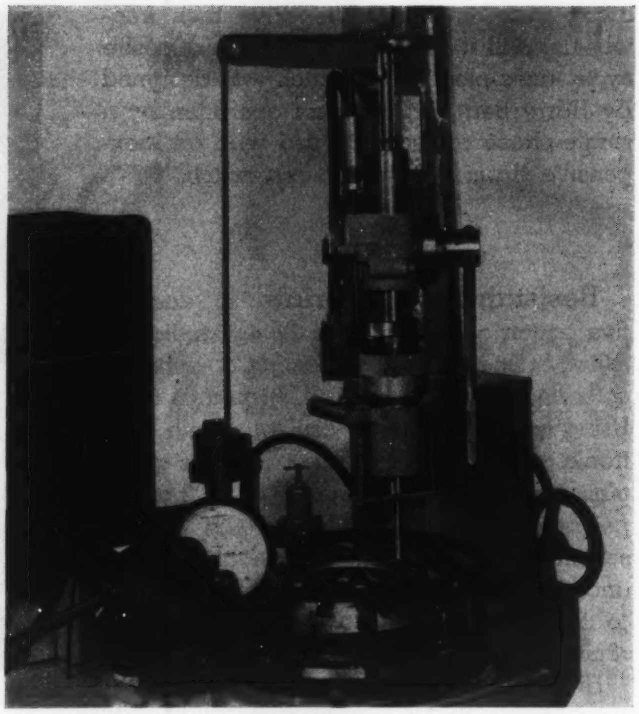
Adjustable Stroke hand-operated hydraulic pump illustrated in section below gives the desired system pressure by varying the fulcrum position of the stroke linkage. Full-stroke low-pressure position is shown in drawing and the maximum-pressure position is indicated in the insert. Located in the pump housing, fulcrum ways position the pivot point of the linkage according to the length of the arm between the piston-rod yoke and the fulcrum nut. Rotation of the pump handle adjusts this length according to the pressure desired.

Double action of the pump is accomplished without the customary metal ball, seat and spring in the piston. Only one ball check is employed at the pump inlet in the cylinder head. A stationary

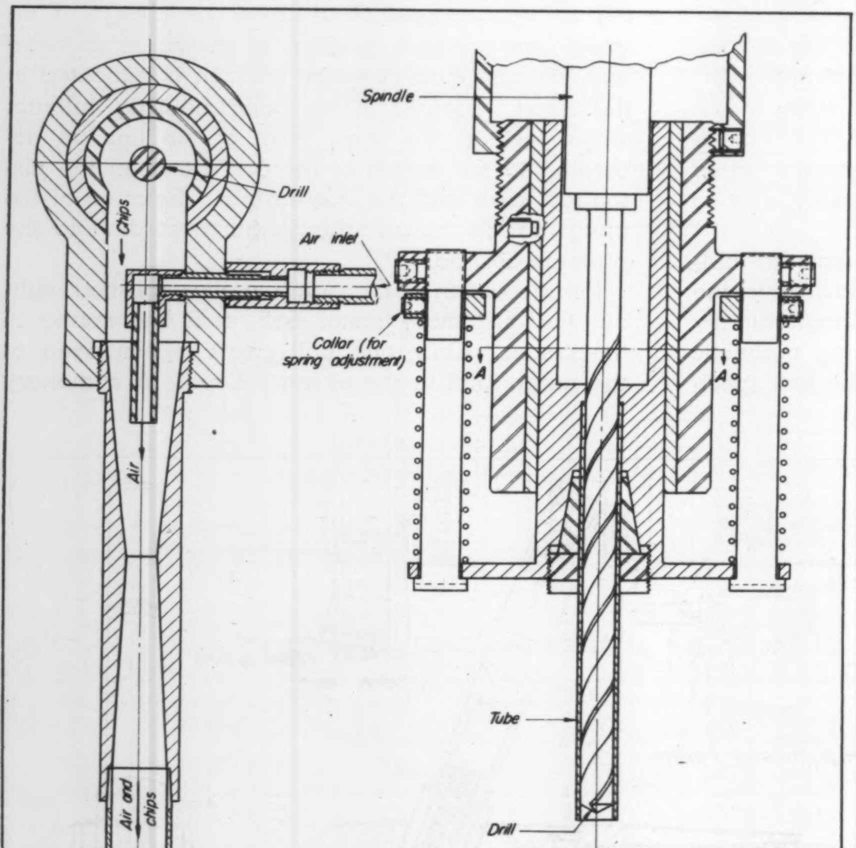


O-ring serves as both seal and piston by-pass seat as indicated in the insert of the piston head. In this way the cylinder can be made relatively short and the pump operated with efficiency, the piston action itself seating and unseating the O-ring at each reversal of stroke.

Invented by S. Schlein, Cleveland, the pump has a steel or light metal casting which incorporates the cylinder, piston block, mounting legs and fulcrum ways. Unit may be completely disassembled and the piston withdrawn by removing a Truarc retaining ring in the cylinder head and a pin in the piston-rod link. In this way maintenance is facilitated without removing pump housing from its installation.



Chip removal by air suction is accomplished with the device illustrated at right and designed by Gisholt Machine Co. The device utilizes shop air supply to remove chips during drilling operations for balancing clutch assemblies. Chips are sucked up a tube which fits closely about the drill, thus precluding the possibility of chips remaining in the assembled parts of the clutch.



Acting as both chip remover and drill guide, the tube is standard steel tubing with 0.001-inch chromium plate on both inside and outside. The inside diameter has about 0.020 to 0.025-inch clearance for the drill before plating. With this clearance cast-iron chips are readily drawn upward between the drill flutes and exhausting them through the venturi with the air jet.

As shown in the drawing at left, section AA, shop air passes through a jet into a venturi, creating a suction in the drill tube to pull air and chips from the point of drilling. Designed for use on a Gifford drill spindle, this device is useful only for drilling into flat-finished cast-iron surfaces to a maximum hole depth of one inch. A counterweight and pulley arrangement, attached to the drill spindle, compensates for the weight of the chip remover and facilitates manual control of spindle feed.

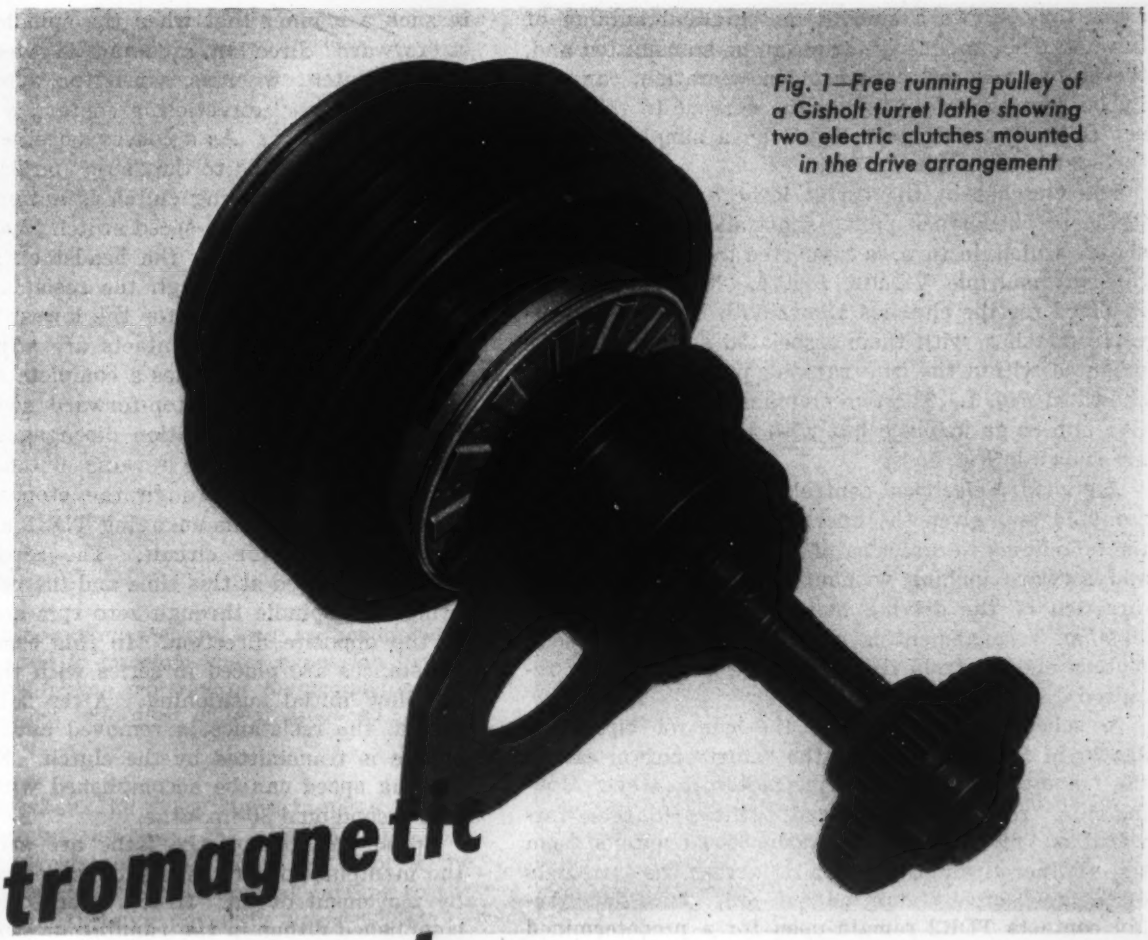


Fig. 1—Free running pulley of a Gisholt turret lathe showing two electric clutches mounted in the drive arrangement

Electromagnetic Clutches

Simplify Machine Control

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FULFILLMENT of the current trend in machine design toward more and more completely automatic operation can be greatly augmented through the use of intercoupled electrical circuits and components. They provide easier control, better flexibility and a minimum of adjustment. An important link in the drive system of any machine is the clutch or clutches and in this program of improved automaticity, electrically actuated units meet the requirements, *Fig.* 1. At the same time, electric clutches provide the fastest and most convenient method of control response.

To exemplify the principles involved in the application of electric clutches to machines in general, an interesting and highly successful design in which they are employed, *Fig.* 2, will be discussed. In this Gisholt saddle type turret lathe, the use of electromagnetic drive clutches has produced a faster and safer semiautomatic machine tool.

Basically, the clutch consists of two parts—the annular-shaped magnet containing the energizing coil, and the segmental armature. Sections of these two parts are shown in *Fig.* 3 along with their respective descriptions. The magnet coil draws from 0.3 to 0.4-ampere at 90 volts dc from a small rectifier in the control panel. The power requirements are, therefore, approximately 35 watts. The magnet, being a highly inductive device, when energized has an inherent build-up delay of approximately 0.1-second. This provides the quick action necessary, but, at the same time allows a smooth and gradual buildup of torque. The amount of torque to be transmitted and, therefore, the acceleration and deceleration, can easily be controlled by varying the current to the magnet coil. This is accomplished by a simple external rheostat in the magnet circuit.

The clutches of the turret lathe are mounted between the headstock pulley shaft and a free-running sheave which, in turn, is connected to the drive motor through multiple V-belts, *Fig.* 4. The small space required for the clutches allows both forward and reverse clutches, with their associated slip rings, to be mounted within the free running pulley arrangement shown in *Fig.* 1. The two clutches with their respective slip rings in place but with the sheave removed are shown in *Fig.* 5.

A standard electrical control station is conveniently mounted and gives the operator complete control of the spindle as to direction of rotation, start and stop, and forward inching without changing the speed or direction of the driving motor. The desirability of such an arrangement is self-evident in that special motors and controls for high cycle duty are not required.

A schematic diagram of the control circuit is shown in *Fig.* 6. Pressing the "start" button causes the traverse and spindle drive motors to start. Moving the "reverse-stop-forward" switch to the "forward" or "reverse" position, connects 90 volts dc from the rectifier through resistor R1 across the terminals of the respective clutch magnet coil. Time-delay relay contacts TDR2 remain open for a predetermined length of time. Resistor R1 is applied to permit adjustment of the total resistance across the rectifier to such a value that a "soft" engagement occurs. Full current to the magnet occurs at the point when TDR2 contacts close. This current value is normally between 0.25 and 0.3-ampere.

Moving the reverse-stop-forward switch from either forward or reverse to stop position, opens the contact to the driving clutch and makes the contact to the zero-speed switch SS1. This is a rotary switch driven by the high-speed clutch shaft and connected in such a manner that when the spindle is driven in a "forward" direction, a contact is set up in the "reverse" clutch; whereas, when the spindle is driven in the "reverse" direction, a contact is set up in the "forward" clutch. As a consequence, when the selector switch is moved to the "stop" position, the clutch opposite to the driving clutch is automatically energized through the zero-speed switch to apply a retarding torque for braking the headstock spindle rapidly to a standstill through the resistance R2. With the headstock gears set for the lowest spindle speed, the zero-speed switch contacts are adjusted to open just as the spindle reaches a complete stop.

Moving the reverse-stop-forward switch from the forward to reverse position disengages the forward clutch and engages the reverse clutch. The switch must always pass through the stop position when this takes place, thus engaging TDR2 and placing resistance R1 in the circuit. The zero-speed switch SS1 is by-passed at this time and the reversing clutch brings the spindle through zero rpm and up to speed in the opposite direction. In this case, appropriate resistances are placed in series with the magnet coil to allow initial cushioning. After full speed is attained, the resistance is removed and the necessary torque is transmitted by the clutch. Full reverse at tapping speed can be accomplished within a fraction of a second on a 30-hp lathe.

Speed changes on the lathe are accomplished by the manipulation of the Gisholt speed-selector dial or by movement of the "Hi-lo" lever. This can be accomplished either in the running or stopped position. Movement of this selector dial engages the pressure switch contacts energizing the time-dalay relay. This immediately opens contacts to the forward clutch (or reverse clutch if reverse rotation is in use at the time) and closes contacts to the zero-speed switch SS2. One set of time-delay relay contacts remain closed for a predetermined length of time, thus engaging the reverse clutch in a braking action to reduce gear speeds for easy shifting. When gear shift-

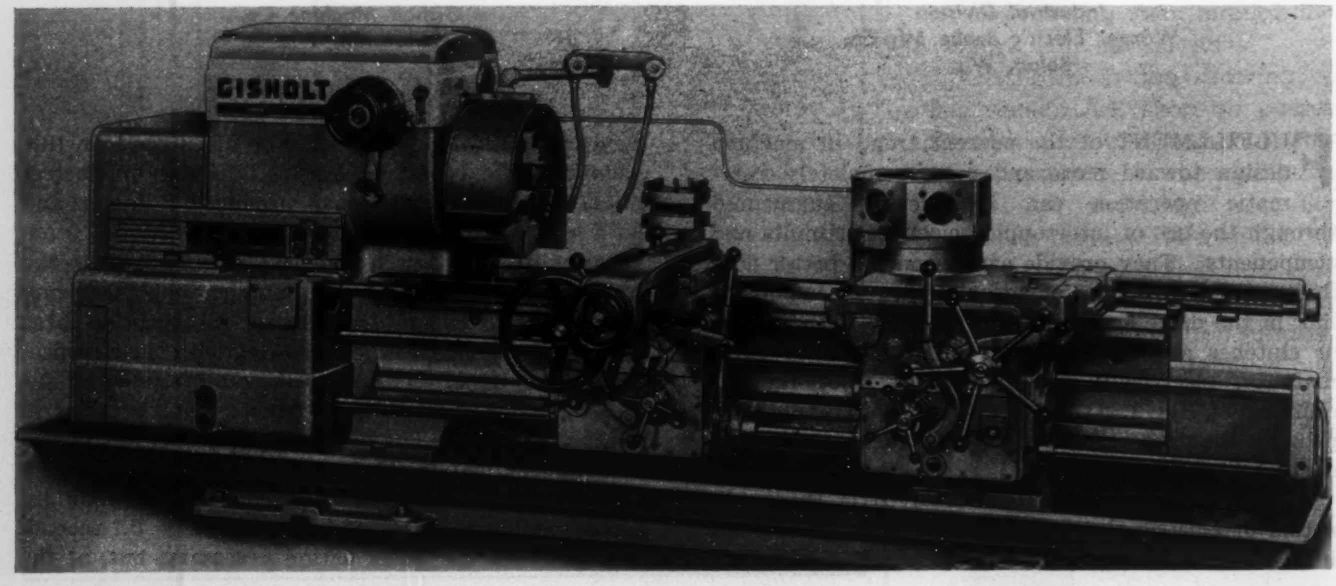


Fig. 2—Gisholt saddle type turret lathe in which a pair of electric clutches provides for operation in either direction

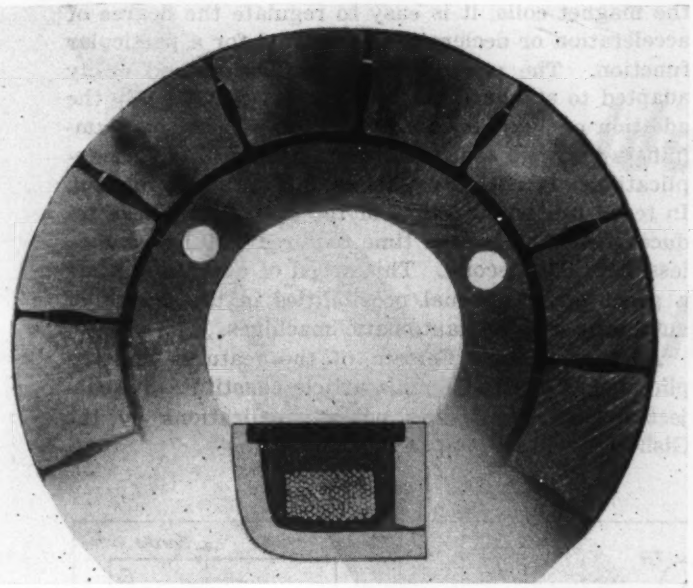


Fig. 3—Cross section of magnet and wear surface of clutch. Segments are used to maintain linear expansion for full contact with the friction material of the magnet section at all times regardless of heat produced

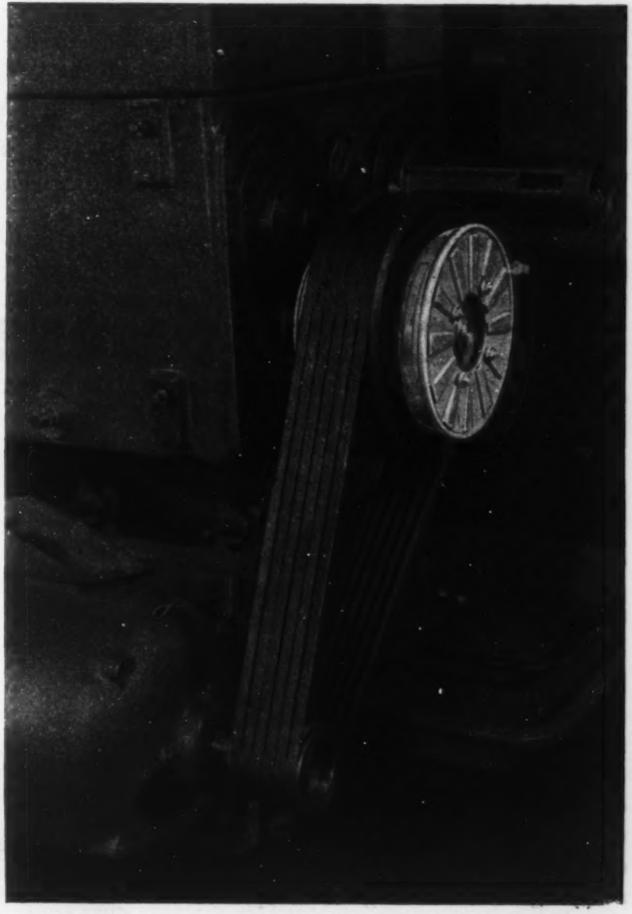
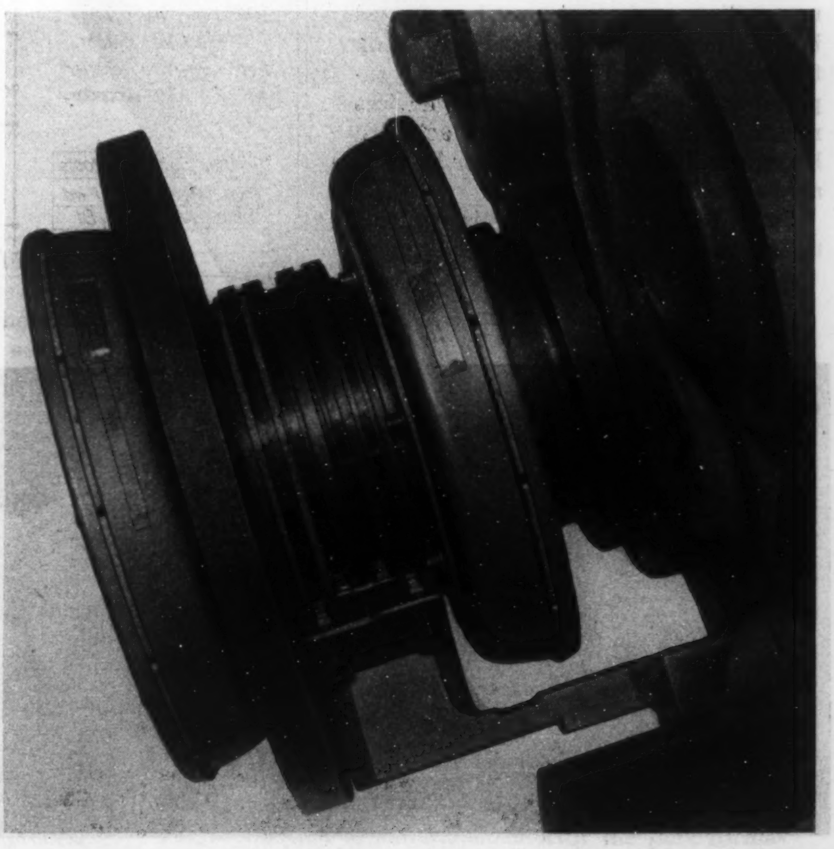


Fig. 4—Above—Multiple V-belt drive to the pulley and clutches of the turret lathe

Fig. 5—Below—The two electric clutches with the pulley removed showing the slip rings for powering the units



ing is accomplished, the delay contact opens the reverse clutch circuit and closes the forward clutch contacts through a resistance R3. When up to speed, the pressure switch drops out and normal current to the clutch is obtained through normally closed TDR1.

Inching is controlled by applying a reduced clutch current through a button so marked. Duration of the pushbutton contact determines the amount of spindle movement. This permits the operator to inch uniformly in any gear range. It is often desirable to chuck pieces with forces greater than can be manually applied through a chuck wrench. An electric chuck wrench is, therefore, a machine accessory. Inching of the chuck to the proper position for entry of the automatic chuck wrench is accomplished as explained above. The wrench itself has the necessary limit switches that will not allow engagement in the chuck while the machine is in movement, or spindle engagement when the wrench is in the chuck.

Several standard machines are performing special inserting or screwdown operations by setting the rheostat TR and adjustable resistance R4 at the desired current to cause the clutch to slip upon reaching the proper torque. This allows a predetermined torque to be put on the screwing operation but, at the same time, disallows the possibility of overloading any of the lathe parts or the piece being screwed down.

One interesting use of the full reversing feature has been the successful finishing of undercuts requiring machining over less than one revolution of a spindle. By synchronizing the operation of the reversing button and the tool feed, repeated cuts over less than 360 degrees can be performed. This repeated reversing is practicable because only a small percentage of the total machine inertia is in the critical location on the driven side of the clutches.

An outstanding result of the functioning of the controls described is that even mishandling or operating in an unconventional manner will not cause damage. Even when operating at high spindle speeds, shifting of gears, reversing of spindle direction, starting or stopping are accomplished effortlessly. There can be no misadjustment or overloading of the two cushion drive clutches regardless of operation.

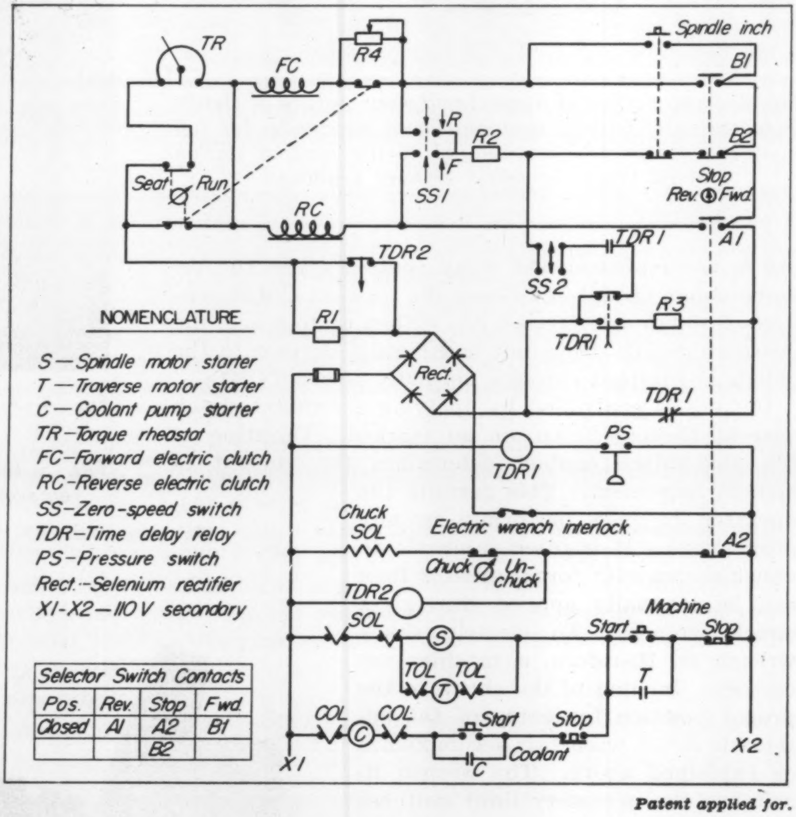
The motor in this type of lathe is constantly turning in one direction. This permits more of the rated horsepower of the motor to be used in actual cutting, requires a minimum of electrical equipment, and a minimum of electrical power consumption.

Start and Stop Operation

Use of these same type electric clutches on an automatic lathe is illustrated in *Fig.* 7. In this case, one of the clutches acts as a brake and complete stopping and starting of a spindle is accomplished eight to ten times per minute. It is increasingly evident that the use of electric clutches and brakes provides a means for faster and more flexible operation. The mere fact that no auxiliary equipment must be actuated before the clutch begins developing torque indicates this method is far superior in speed and efficiency to devices requiring mechanical linkages actuated hydraulically, pneumatically, or by solenoid actuation.

Since torque developed is proportional to the current passing through the magnet coils, it is easy to regulate the degree of acceleration or decleration as desired for a particular function. The wiring is straightforward and easily adapted to standard machine control circuits. By the addition of auxiliary controls, such as electronic amplifiers and grid controlled thyratrons, many more applications are not only feasible, but entirely practical. In tests, full buildup time of the magnet has been reduced from the normal time required of 0.1-second to less than 0.01-second. This speed of operation offers a great many unusual possibilities in the design of automatic and semiautomatic machines.

Authors' Note: Certain of the features and applications described in this article constitute the subject matter of pending patent applications by the Gisholt Machine Company.



NOMENCLATURE

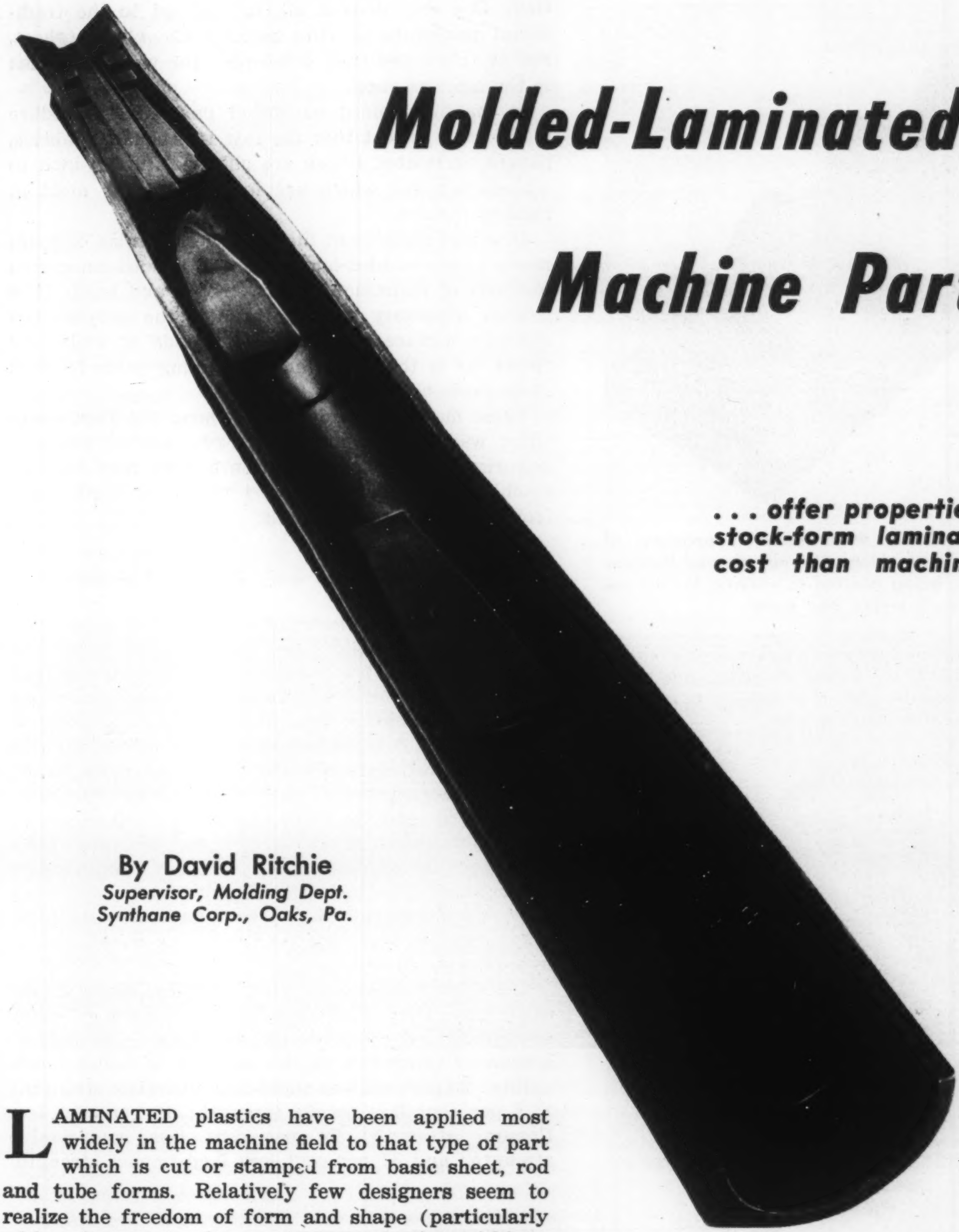
S—Spindle motor starter
T—Traverse motor starter
C—Coolant pump starter
TR—Torque rheostat
FC—Forward electric clutch
RC—Reverse electric clutch
SS—Zero-speed switch
TDR—Time delay relay
PS—Pressure switch
Rect.—Selenium rectifier
X1-X2—110 V secondary

Selector Switch Contacts			
Pos.	Rev.	Stop	Fwd.
Closed	A1	A2	B1
		B2	

Patent applied for.

Fig. 6 — Above — Schematic control circuit for the turret lathe shown in Fig. 2

Fig. 7—Left—Electric clutches on this Gisholt automatic lathe permit complete stopping and starting eight to ten times per minute



Molded-Laminated Machine Parts

. . . offer properties on par with stock-form laminates at lower cost than machined laminates

By David Ritchie
Supervisor, Molding Dept.
Synthane Corp., Oaks, Pa.

LAMINATED plastics have been applied most widely in the machine field to that type of part which is cut or stamped from basic sheet, rod and tube forms. Relatively few designers seem to realize the freedom of form and shape (particularly with reference to changes in cross section within a part) which can be obtained with laminated plastics by means of molded-laminated and molded-macerated methods of manufacture. An excellent example of the complex parts which can be produced by the molded-laminated method is the stocking examiner form shown in *Fig.* 1.

Designers and engineers might well consider the molding technique used to produce such parts, and thereby learn to what degree they may allow themselves more latitude in specifying laminated phenolics and melamines for parts requiring the particular combinations of electrical, mechanical, physical and chemical properties characteristic of the materials.

Fig. 1—Above—Intricately shaped parts such as this stocking examiner form used in textile industry (see drawing, Fig. 6), are readily made by molded-laminated process

In making molded-laminated parts, the raw laminations, impregnated with uncured resin, are cut to special shapes depending upon the ultimate part shape, stacked up, and placed in a mold which cures the material, under pressure, to finished part size. Polymerization is simultaneous with the part forma-

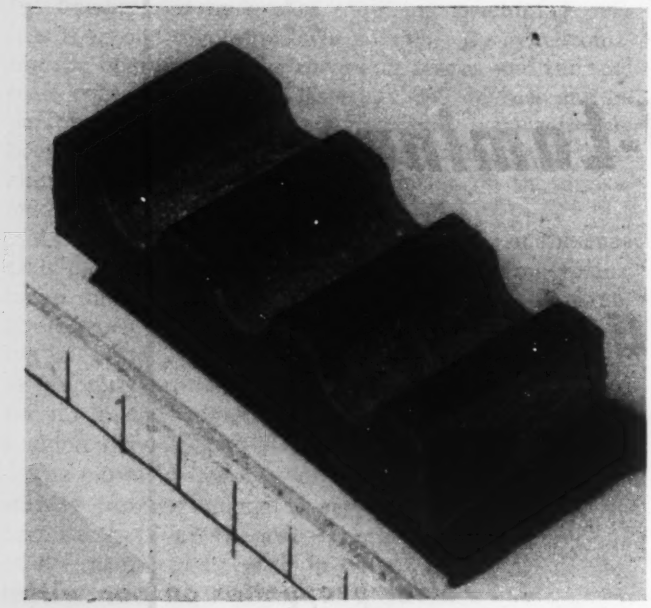
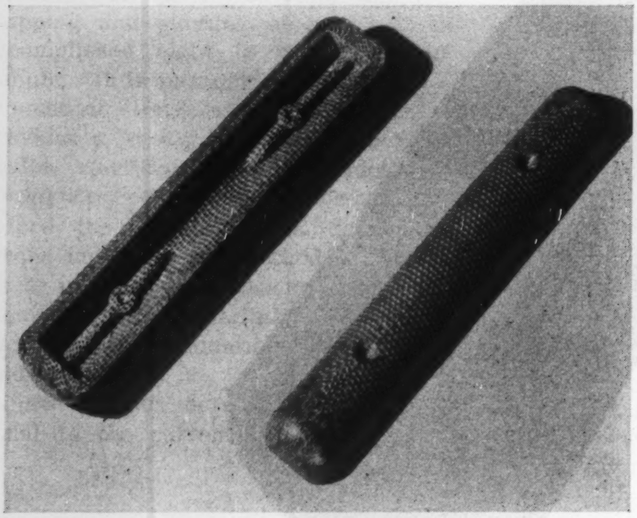


Fig. 2 — Above — Insulating wire clamp is example of molded-laminated part in which uniformly shaped laminae are used in stack-up, being pressed to varying thicknesses required within the mold

Fig. 3 — Below — Molded-laminated high-dielectric clamp cover for welding electrode holder in which additional narrow strips of laminae are placed in stack-up to produce the strengthening ribs



tion. One step does it all, in contrast to the traditional procedure of first making the blank (sheet, rod or tube) and then developing the part therefrom in the machine shop.

In making molded-macerated parts the procedure is the same except that the raw impregnated fabrics, papers or matted fillers are chopped into ⅛-inch to ½-inch squares which are loaded into the mold in random fashion.

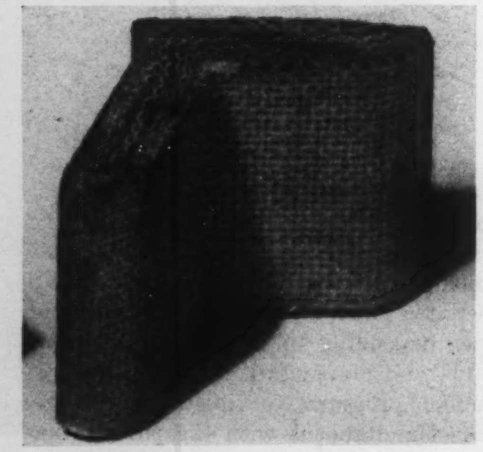
It is also significant that the overall finish of parts made by the molded-laminated and molded-macerated methods of manufacturing is smooth and hard. It is seldom necessary to cut through the polymerized resinous surface and expose the ends of embedded fibers, as is the case when machining parts to final shape from blanks.

These methods are desirable when: (1) Part quantities warrant the mold cost, (2) overall finish is important, or (3) configuration is such that difficult machining would be required to attain final shape from stock forms or blanks.

Properties on Par with Regular Laminates

As for physical, electrical and chemical properties, molded-laminated parts are generally the equivalent of regular laminates in the usual sheet, rod and tube forms. In one series of comparative tests, short-time dielectric strengths were found to be identical at 325 volts per mil, flexural and compressive strengths were identical at 20,000 and 38,000 psi respectively, and Izod impacts were the same at 3.2 psi minimum. Tensile strength in the molded-laminated specimen was only slightly lower than in the machined piece (9,000 psi as against 9,500 psi), but resistance to water absorption had been improved (only 0.5 per cent in contrast to 1.7 per cent on a 24-hour test) thanks to the fact that no fiber ends were exposed by sawing or cutting.

Tests on molded-macerated samples, made at the same time, showed equally good resistance to water absorption, but the following sacrifices from molded-laminated properties in the interest of easier moldability: 20 per cent less short-time dielectric strength; 13.3 per cent less tensile strength; 40 per cent less flexural strength; 29 per cent less compressive strength; and 37 per cent less Izod impact strength.



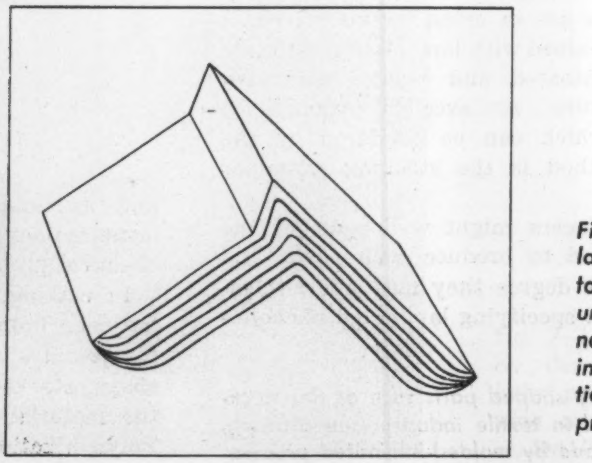


Fig. 4—Left—This molded-laminated auto distributor part is produced of uniformly shaped laminae which are bunched in the mold at the junction of the two legs to produce the thickness required

Fig. 5—Right—Example of intricate stack-up used to produce molded-laminated part of complex shape. This stack-up was used to mold the part shown in Fig. 6

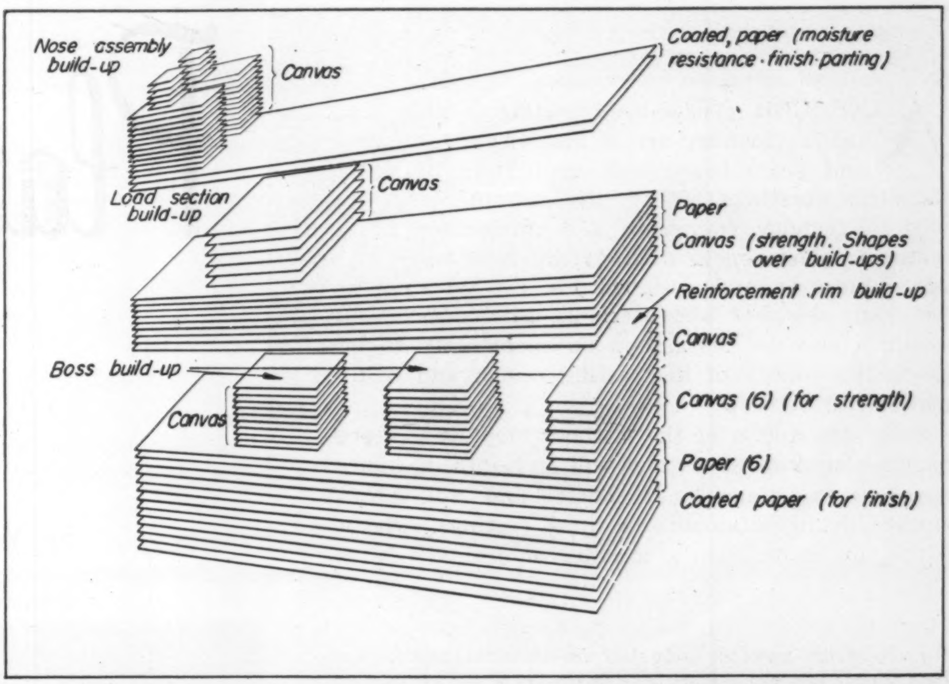
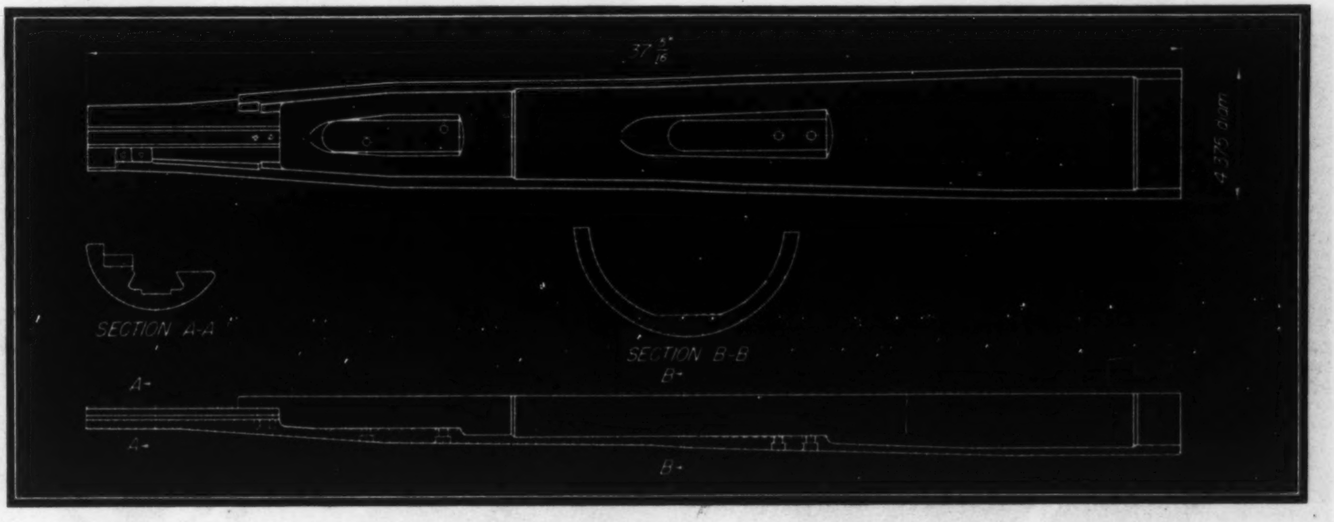

Nose assembly build-up
Canvas
Coated, paper (moisture resistance · finish·parting)
Canvas
Load section build-up
Paper
Canvas (strength. Shapes over build-ups)
Reinforcement rim build-up
Canvas
Boss build-up
Canvas
Canvas (6) (for strength)
Paper (6)
Coated paper (for finish)

Fig. 6 — Below — Stocking examiner form used in textile industry (see photo, Fig. 1), is of intricate varying cross section at portions of its length. Over three feet long, it is molded of laminae by using the intricate stack-up shown in Fig. 5

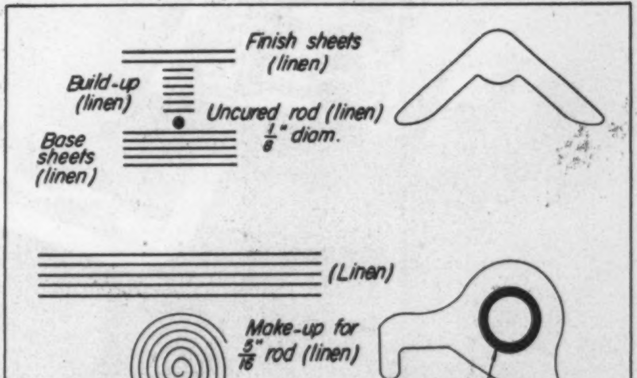

37 5/16
4.375 diam.
SECTION A-A
SECTION B-B
A-
B-
A-
B-

In all three cases—machined, molded-laminated and molded-macerated specimens—the specific gravity (at 1.36) and the Rockwell hardness (at 105 to 110 on the M scale) were the same.

There are three principal ways by which variation in configuration and cross section is attained in the manufacture of molded-laminated parts. First, if the sections of the part can be conceived of as a "bent" form of reasonably uniform thickness, the raw impregnated laminations may all be cut to the same shape and simply stacked up, the bending occurring inside the heated mold during the curing process. Minor variations (10 to 20 per cent) in thickness are achieved by merely pressing the fibers of the laminations more closely together at the thin points. The small insulating wire clamp shown in *Fig.* 2 is an example of this technique. The part shown in *Fig.* 3 (a high-dielectric clamp cover for welding electrode holder) is of the same type, with

(*Concluded on Page* 178)

Fig. 7—Below—Examples of laminae stack-ups and the parts produced after molding


Finish sheets (linen)
Build-up (linen)
Uncured rod (linen) 1/8" diam.
Base sheets (linen)
(Linen)
Make-up for 5/16" rod (linen)
Metal bearing inserted after blank is drilled
Linen
Drilled hole

Plaster-Mol

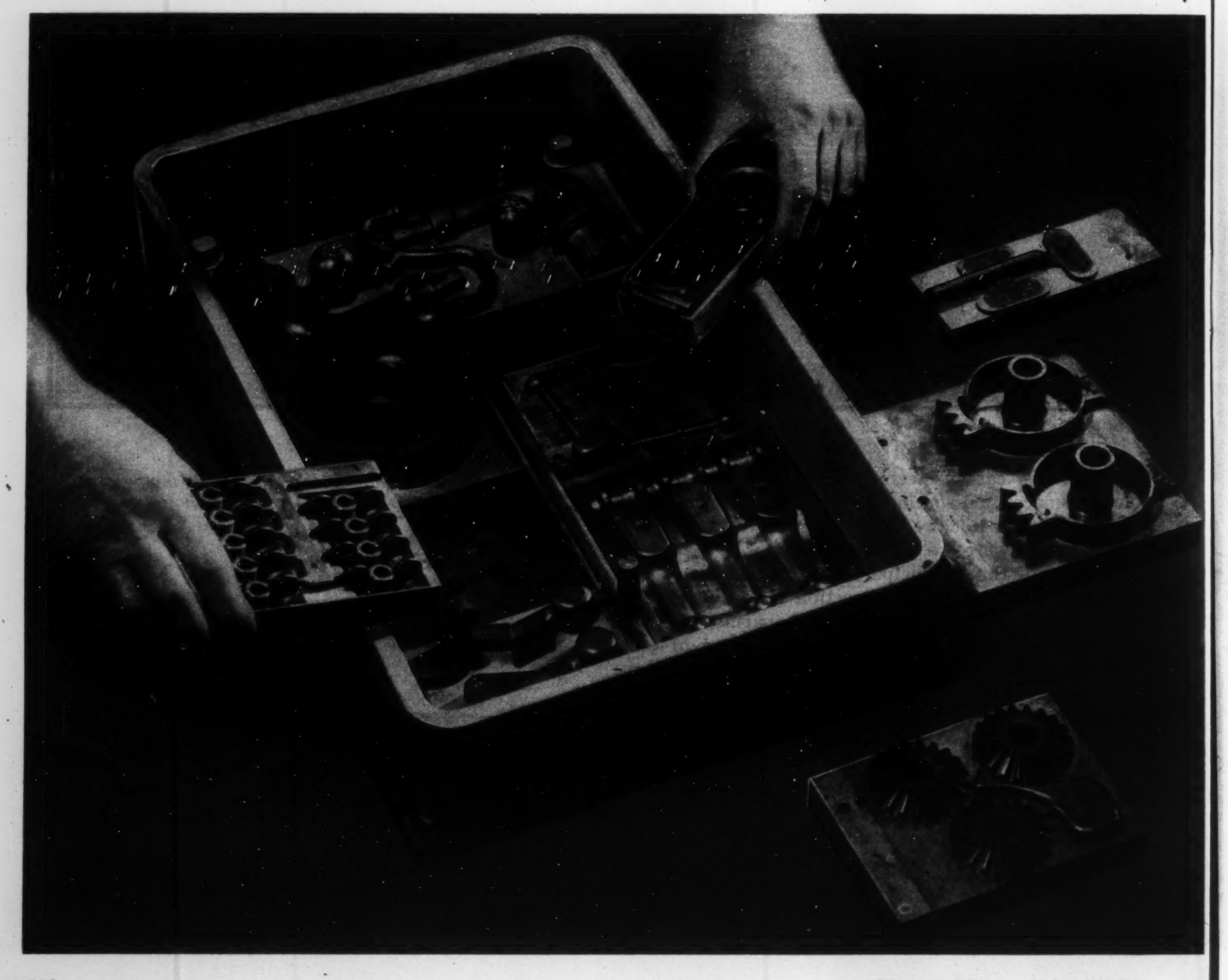
. . . Selections of materials

By W. G. Wilkins
President
Universal Castings Corp.
Chicago

ALTHOUGH plaster-mold casting is an ancient foundry art, it has within recent years found wide application to industrial castings. With the advent of modern foundry equipment and production methods, plaster-mold castings are now being engineered and designed for extensive use. Any designer who overlooks their possibilities may be passing up an opportunity to improve the quality of his casting design and reduce manufacturing costs.

Brief description of the methods employed in producing plaster-mold castings will be helpful in understanding the dimensional control and well-defined surface detail obtainable in these castings. Plaster molds are made from a mixture of ordinary indus-

Fig. 1—Metal patterns mounted on interchangeable unit strip plates are assembled in a flask. Number of patterns per plate is determined by the rate of production specified



d Castings

and design considerations

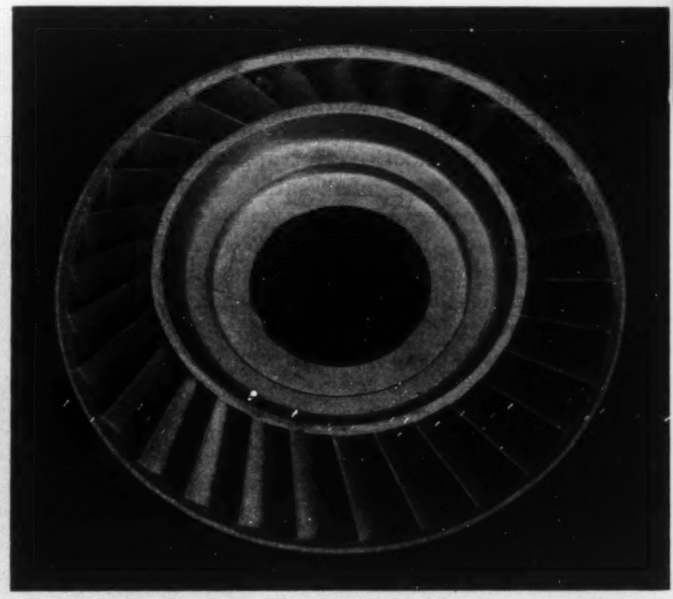


Fig. 2—Cast aluminum turbine wheel for automotive torque converter showing smooth surface of the curved blades

trial plaster, talc and water. The mixture is hot and in the form of a slurry as it flows by gravity from the mixing head into the flask. In this state it readily forms itself around and over highly polished brass patterns, picking up the finest engraved detail of the pattern. After a short period, during which the plaster takes on its set and becomes solid enough to hold its shape, the mold is extracted from the flask with a vacuum head. The molds are always made in cope and drag sections.

Drying of the molds is done in a continuous oven, where the free moisture and also the water of crystallization is driven off. No moisture is present when the molds receive the metal, and consequently no steam or gases are formed. After being thoroughly dried, the two halves of the mold are assembled. If cores are required they are set in the drag prior to assembly of the cope. Cores are produced from a similar plaster mixture and are baked at the same temperatures as the molds. Coreboxes are constructed with the same precision and care as the patterns. They are always made of engraver's brass, highly polished. Cores produced are accurately sized, have a smooth glossy surface, and the internal cavities or recesses which they form in the casting reproduce these qualities.

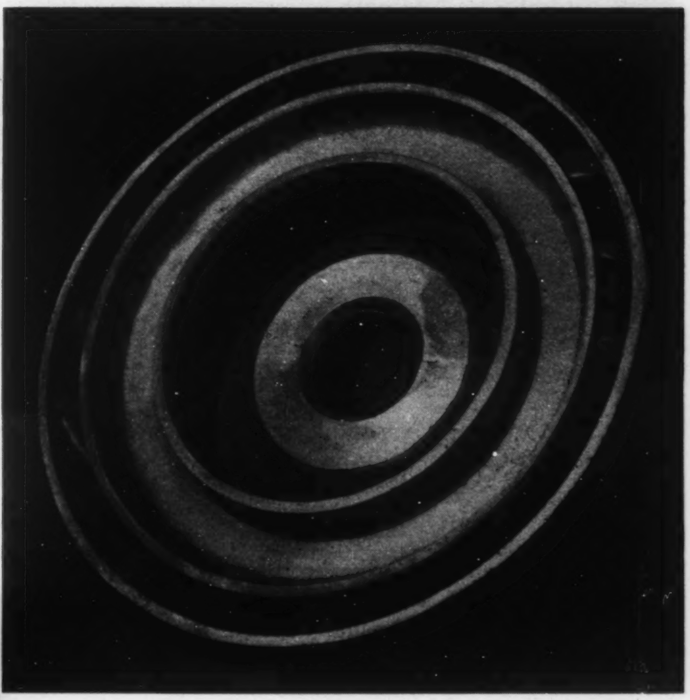


Fig. 3—Cast aluminum wheel for automotive torque converter showing curved blades tapering off to sharp edge

After the molds have been poured, and the castings solidified, the plaster is broken away from the casting and the cores, if any, are washed out with a high-pressure jet of water. Smooth surfaces of the casting are therefore not nicked or scratched, and the dimensional accuracy, together with the sharp detail, is undisturbed. Completely dehydrated plaster has no chilling action on the metal and its low thermal conductivity provides for slow cooling of the metal in the molds.

The resulting slow solidification of the castings tends to prevent any stress concentration and also promotes machinability and uniform hardness. Wearing qualities are materially improved. Plaster molds permit accurate control of metal shrinkage, and distortion and warping of castings is negligible. The casting surfaces have a uniformly smooth finish upon removal of the plaster.

Metal Compositions

It is possible to cast a wide variety of alloys in plaster. Some of these alloys are listed in the accompanying table. All are copper base metals, except UC 100.4 aluminum. Pure copper, although not listed, may also be cast.

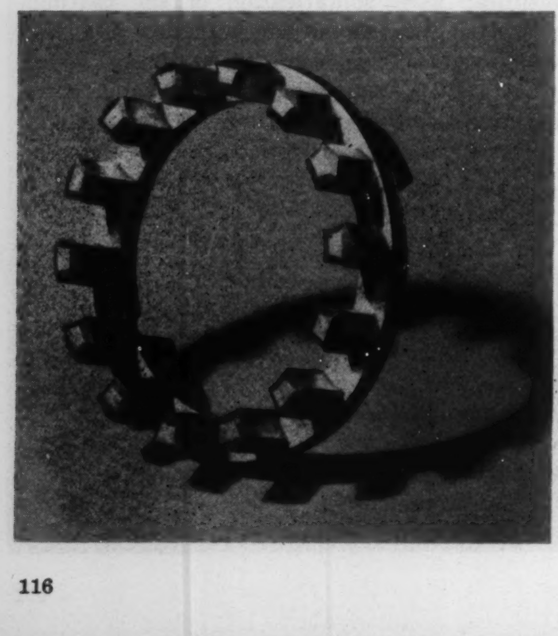
Yellow brass No. 10 is used in greater quantity than any other composition. It is lowest in cost and will meet the requirements of most ordinary brass metals. Its physical strength is good. Its toughness rating is somewhat higher than the average bearing brass but it can easily be machined. It has a wide application in miscellaneous castings where unusual physical requirements are not a factor. Typical uses are brackets, brush holders, frames, ornamental castings, etc.

Manganese bronze XX is a high-strength material, with a minimum tensile strength of 95,000 psi and yield strength of 60,000 psi. Hardness averages 190 Brinell. This alloy is used largely for gears, clutches and other types of castings, which require unusual wear-resisting characteristics and where stress concentration is high. The metal casts easily and will reproduce excellent detail. It has lower ductility than some of the other alloys due largely to the manganese content and its resultant high tensile strength. It is not as easily machined as yellow brass, but with the aid of carbide-tipped tools it handles satisfactorily. Corrosion resistance is good.

Aluminum bronze is next in line to manganese bronze for physical strength application. It has a higher ductility and is unusually tough. Resistance to shock and impact loading is good. Wearing qualities are excellent. Although it is not entirely free-machining, it can be cut rapidly with the proper carbide-tipped tools. Threading can be accomplished satisfactorily. The alloy has good corrosion-resisting properties and finds considerable application in pump impellers, valve parts and bodies, gears and levers. It has a tensile strength of 83,000 psi and a yield strength of 30,000 psi.

Nickel brass has good ductility and corrosion-resistant qualities. Nickel content adds materially to corrosion-resistant properties. It is used in lock cases, handles and ornamental designs, where a white metal finish is required on exposed parts. It also has a limited use in dairy equipment and food processing machinery. It casts well in the foundry and is produced as one of the standard alloys. The cast surface is unusually smooth and glossy. With a casting of nickel brass alloy, very little polishing is necessary to give it either a white satin or mirror finish. Surface porosity is well controlled and rarely appears as an objectional defect in polished surfaces.

Fig. 4—Manganese-bronze roller retainer. Pockets are cast smooth and to size for receiving rollers



Nickel brass 22 per cent has essentially similar physical characteristics to 15 per cent nickel. Uses are confined largely to food processing equipment and dairy equipment. It is almost always subject to highly polished finishes in its end uses. Metal structure must be dense and highly polished surfaces free from porosity. This is particularly true when the surfaces of the casting are in contact with food. Any surface porosity which would permit secretion of bacteria would promptly disqualify the casting. Because of its wide use in dairy equipment it has acquired the trade name of "dairy metal". When given a high polish it has the same luster as stainless steel.

Developed for Plaster Castings

Aluminum UCC 100.4 is also known as Tenzalloy, developed particularly for plaster casting. Tensile strength is 25,000 psi as cast. The alloy responds to heat treatment, which materially increases the tensile strength and ductility. Surface of this alloy as cast has a bright smooth-velvet appearance. It will take a bright aluminite finish satisfactorily. This is the lowest cost material of the available group of alloys. Uses include instrument frames and cases, and machine parts such as levers and housings. Numerous other applications are made when weight and cost are important factors.

Other compositions such as beryllium copper and

Fig. 5—Four castings show: Gear teeth cast in face of wheel with other operational details, lawn mower gear having 3-point clutch lugs inside hub which do not show, spur gear with cast square hole in hub, and compound gear with cast teeth in face and edge

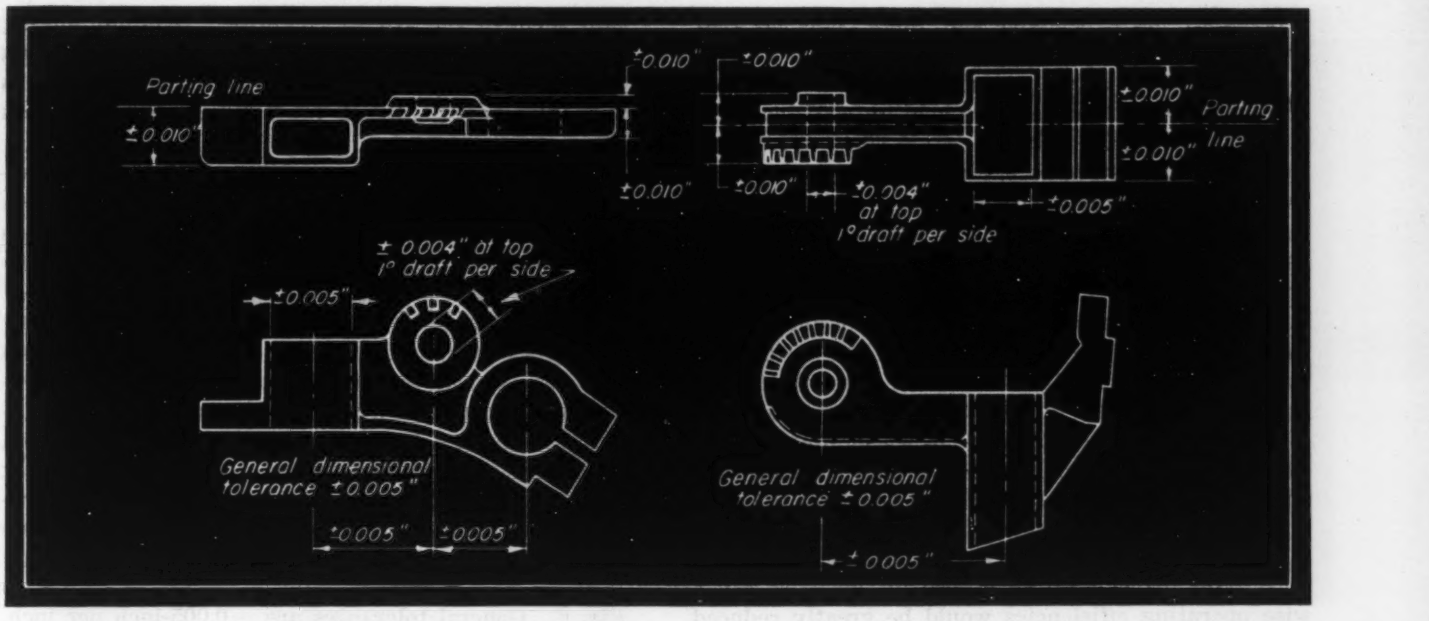
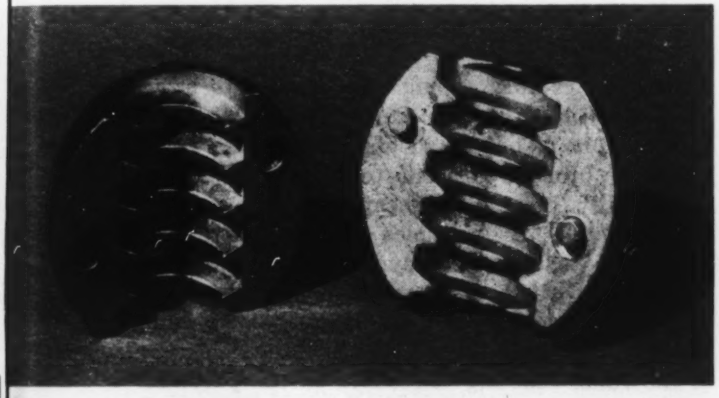

Parting line
±0.010"
±0.010"
±0.010"
±0.010"
±0.010"
±0.010"
Parting line
±0.010"
±0.004" at top 1° draft per side
±0.005"
± 0.004" at top 1° draft per side
±0.005"
General dimensional tolerance ±0.005"
±0.005"
±0.005"
General dimensional tolerance ±0.005"
±0.005"

Fig. 6—Above—Although general tolerance indicated is ± 0.005-inch per inch it is necessary to have ± 0.010-inch per inch across parting lines and on other dimensions where length and section changes become factors

Fig. 7—Below—Special thread cast in spherical split nut for assembly without machine work



silicon aluminum bronze are also cast. Beryllium copper, although not listed as a standard, produces excellent castings in plaster. It can be heat treated to high physical strength and hardness ranging between 400 and 440 Brinell. Application includes a variety of nonsparking tools, machine parts and die blocks. Other special alloys can be cast as required within the thermal limits of the plaster.

Whenever possible, the designer should use standard alloys to reduce costs. Foundries generally limit the number of alloys cast to the minimum that will meet their customers' requirements. This is particularly desirable in plaster molding because of the necessity of grouping a number of patterns for different customers in one flask from which all castings must, of course, be in the same alloy. Higher scrap loss inevitably results from casting special analyses foreign to the everyday standard production.

Designers should consider these higher cost factors when selecting an alloy. Consultation with the foundry, prior to making the selection, will frequently benefit the designer as well as the foundry. In view of the high degree of detail obtainable in plaster mold castings, using alloys which are adaptable to the process, the closest co-operation between the designer and the foundry is necessary if full benefit is to be derived and production costs minimized.

Designing For Plaster Castings

Because of the flexibility of the process relating to production, dimensional accuracy, surface detail, and irregular sections, no comprehensive set of instructions can adequately be developed. For example: It is not necessary, when designing for plaster castings, to limit their use because of quantity requirements. Quantities of 25 and 50 pieces are produced as readily as 100,000 pieces. It is merely a matter of providing the required number of patterns, ***Fig.*** **1**, to meet any given production schedule.

Patterns can readily be duplicated from the master to provide for increased production as required. The flexibility of the process does, therefore, eliminate costly tooling during development and experimental stages. As production increases, it is only necessary to add additional pattern equipment by making duplications of the master. Patterns used in the plaster

Typical Physical Properties of Casting Alloys

Type of Material	Ultimate Tensile Strength (psi)	Yield Strength ½% Elong. (psi)	Elongation in 2" gage (%)	Brinell Hardness	Rockwell Hardness
No. 10 Brass	50,000	25,000	15	83-110‡	50-70 (RB)
No. 20 Aluminum Bronze	83,000†	30,000	9.0	150-185§	80-90 (RB)
High Strength Manganese Bronze	95,000	60,000	5.0	165-210§	85-95 (RB)
Silicon Aluminum Bronze	59,000†	29,000	15	116-137§	65-75 (RB)
15% Nickel Brass.	50,000	47,000	4.0	150-185§	80-90 (RB)
UC 100.4 Aluminum*	25,000	22,000	1.0	62-74‡	70-80 (RE)
22% Nickel Brass.	50,000	47,000	3.0	150-185§	80-90 (RB)

† This alloy responds to heat treatment.
* After 21 days natural aging.
§ 3000 kg load.
‡ 500 kg load.

process are not expendable and, there being no wear, they never need replacement.

Since master patterns must be precisely constructed, dimensional tolerances are held to 0.003-inch with all surfaces highly polished. This care in construction of the pattern is necessary in order to obtain the dimensional accuracy and smooth surface of the castings. Alteration to the master pattern is easily accomplished if the designer finds it necessary to make changes.

A recent and important application of plaster-cast surfaces is for torque converters in the automotive industries. The rotating wheels of these fluid drive units require close dimensional accuracy combined with a very smooth finish. The wheel illustrated in ***Fig.*** 2 has metal sections in the blades which vary from a sharp edge at the tail to ⅜-inch in the nose, and metal surfaces approaching a polished finish. Since liquids flow over the surface of the blades they must offer little or no resistance to this flow, otherwise operating efficiencies would be greatly reduced.

Has Knife-Edge Section

Blade form of the wheel casting illustrated in ***Fig.*** 3 cannot be die cast or fabricated. To sand cast them would require an extremely expensive polishing operation on all surfaces. In addition to sacrificing dimensional accuracy, blade thickness necessarily would be increased to compensate for the chilling action and freezing off of thin sections. The wheels illustrated are cast in aluminum with the trailing edges of the blades on both wheels cast to a knife edge thickness, while other sections of the blades in the smaller diameter wheel do not exceed 3/32-inch. The radiused nose of the blade in the larger wheel is approximately ⅜-inch in thickness, and tapers back to a sharp edge. This accuracy combined with thin metal sections is a necessary design requirement. Plaster, being a poor conductor of heat, is ideal for running the thin sections.

Illustrated in ***Fig.*** 4 is an interesting manganese-bronze roller bearing retainer casting. A great deal of costly machining time has been eliminated by plaster casting this retainer. No machine work is required within the pockets, the rollers being dropped into them in the as-cast condition. Straight milling through the pockets with a subsequent end milling operation to form the radius within the pockets has been eliminated. Other types of bearing retainers are also cast in plaster.

A group of typical gear castings, produced by plaster molding, is shown in ***Fig.*** 5. Usually gear teeth are cast to size for service requirements such as lawn mowers, washing machines, spotlights, and similar applications dealing with simple transmission of power and motion. Whenever the accuracy of certain types of spur gears calls for machining, it can be accomplished with a shaving die. Similar operations can be performed on other surfaces where machined accuracy is required, such as cam surfaces, square and rectangular slots. The designer must keep in mind that plaster molding is not a substitute for machined tolerances as such. The process has its limitations.

Brush holder castings have tolerances indicated in ***Fig.*** 6. General tolerances are ±0.005-inch per inch, where the dimension is not across a parting line or controlled by a loose core. The tolerance on dimensions across the parting line is generally held to ±0.010-inch per inch. Whenever stock is required for facing, boring or turning 1/32-inch is sufficient, unless the designer specifies more stock for finish.

Holes Are Cast to Size

Small holes for tapping can be cast to size, particularly where the core can be formed as a part of the main body of the mold. If separate cores are needed to produce holes up to ½-inch diameter, they can usually be drilled cheaper than by making a separate core. Drilled holes can be spotted accurately in the pattern, thereby eliminating drilling fixtures. Separate cores, whether they be used for straight round holes or irregular internal openings in the castings, are produced from metal coreboxes made to the same exacting tolerances as the patterns.

In the same manner as with other methods of coring castings, cores must be supported and held rigidly within the mold. Thus adequate core print must

(*Continued on Page* 192)

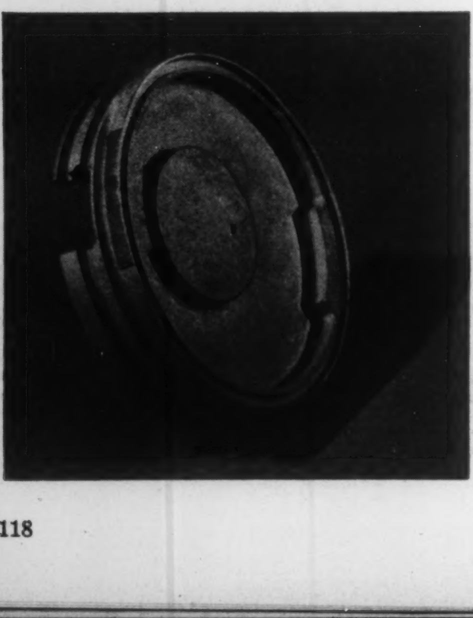


Fig. 8—Left—Aluminum control drum with cast spiral cable groove and guide groove in face

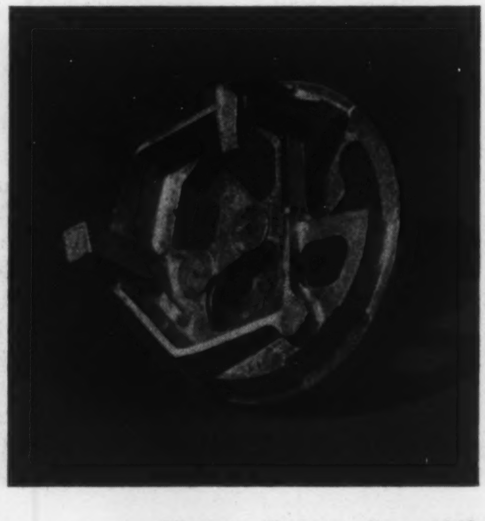


Fig. 9 — Right—Casting illustrating intricate cored sections incorporating support bracket. Several parts have been consolidated into the one casting

Optimum Diameters of Flexible-Cable Pull-Wires

By Macon Fry
Ordnance Consultant
Harrington Park, N. J.

AN interesting case occurs when flexible cable pull-wires are required to operate around bends. It will be shown that, for given conditions of curvature of bend and fiber stress in the pull-wire, there is an optimum diameter of wire that provides maximum pull. Also it will be shown that the best material to use in such pull-wires is not necessarily that which has the highest tensile strength; a criterion or figure of merit will be set up for indicating the relative merit of a given material. *Fig.* 1 shows a pull-wire subject to tension as it bends around a curve.

Let: T = Tension in wire, lb
r = Radius of bend, in.
c = Radius of wire, in.
I = Moment of inertia of wire section, in.^{4}
M = Bending moment on wire, lb-in.
E = Young's modulus, psi
σ_B = Bending stress in wire, psi
σ_T = Direct tensile stress in wire, psi
σ = Total stress = $\sigma_B + \sigma_T$.

From strength of materials:

$$M = \frac{EI}{r} \qquad (1)$$

and

$$\sigma_B = M\frac{c}{I} \qquad (2)$$

hence

$$\sigma_B = \frac{Ec}{r} \qquad (3)$$

also

$$\sigma_T = \frac{T}{\pi c^2} \qquad (4)$$

therefore

$$\sigma = \frac{Ec}{r} + \frac{T}{\pi c^2} \qquad (5)$$

or

$$T = \pi\left(\sigma c^2 - \frac{E}{r}c^3\right) \qquad (6)$$

The maximum available tension for a given allowable stress occurs when $dT/dc = 0$:

$$\frac{dT}{dc} = \pi\left(2\sigma c - 3\frac{E}{r}c^2\right) = 0 \qquad (7)$$

or

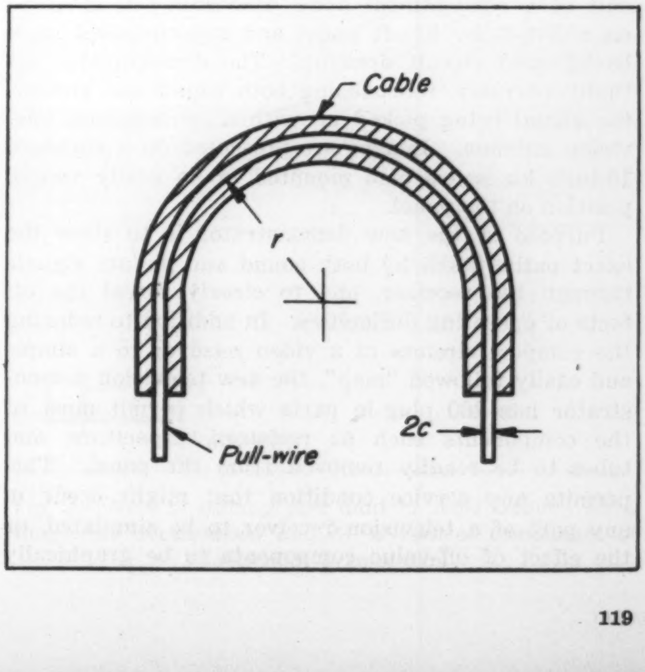
$$c = \frac{2}{3}\frac{r\sigma}{E}$$

Substituting this value of c in Equation (6):

$$T = \frac{4}{27}\pi r^2\frac{\sigma^3}{E^2} \qquad (8)$$

$$= 0.46542\, r^2\frac{\sigma^3}{E^2} \qquad (8a)$$

Fig. 1—Section through pull-wire subject to tension as it bends around a curve



From Equation 8 it can be seen that the ratio σ^3/E^2 constitutes a figure of merit; the higher this ratio the more the wire will support under given conditions. This demonstrates that it is not necessarily the strongest material which is best for this purpose, but the material having the greatest ratio of strength cubed to modulus squared. A similar situation prevails when the member is rectangular as in the case of metal belts passing over pulleys (*Fig.* 2).

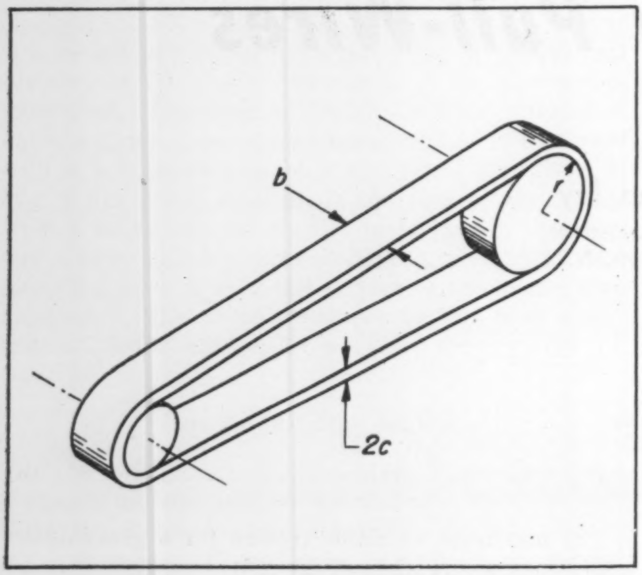


Fig. 2—Metal belt working over pulleys presents condition, relative to optimum thickness and strength, similar to that encountered with pull-wires

Let c = one-half the belt thickness, in.; and b = belt width, in.; the other symbols being the same as in the preceding case. In this case $\sigma_B = Ec/r$ as before, in Equation 3. But

$$\sigma_T = \frac{T}{bc} \quad \text{(9)}$$

therefore

$$\sigma = \frac{Ec}{r} + \frac{T}{bc} \quad \text{(10)}$$

or

$$T = b(\sigma c - \frac{E}{r} c^2) \quad \text{(11)}$$

As before, maximum T is when $dT/dc = 0$.

$$\frac{dT}{dc} = b(\sigma - 2\frac{E}{r}c) = 0 \quad \text{(12)}$$

or

$$c = \frac{1}{2}\frac{r\sigma}{E} \quad \text{(13)}$$

Substituting this value of c in Equation 11.

$$T = \frac{1}{4}\frac{br\sigma^2}{E} \quad \text{(14)}$$

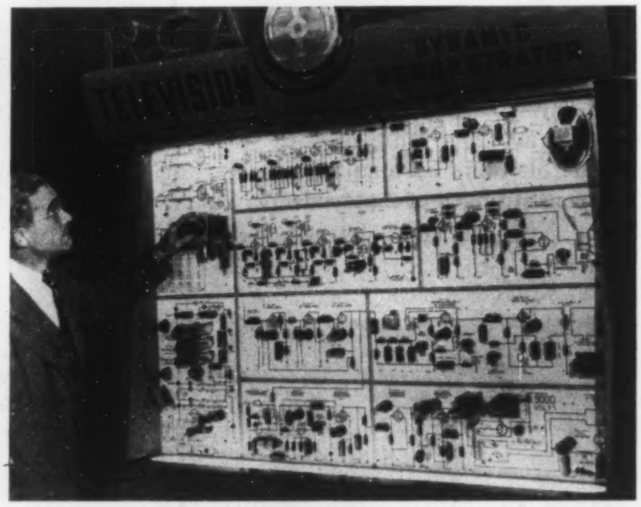
In this case it will be seen that the figure of merit for the material is σ^2/E. Here again, the strongest material is not necessarily the best to use.

Television "Bread Board" Revealed

A COMPLETE and operating 30-tube television receiver spread out on an upright panel to present an "operating blueprint" of the components and circuits of a television receiver was recently displayed by the tube department of the Radio Corp. of America.

Resembling a giant operating schematic, the "breadboard" model receiver has every component and circuit of a conventional home television set, mounted on a 3½-ft by 5½-ft panel and superimposed on a background circuit drawing. The demonstrator actually operates, reproducing both sound and picture, the signal being picked up with a conventional television antenna. Images are presented on a standard 10-inch kinescope also mounted in an easily viewed position on the panel.

Purpose of the new demonstrator is to show the exact paths taken by both sound and picture signals through the receiver, and to clearly reveal the effects of operating difficulties. In addition to reducing the complex circuits of a video receiver to a simple and easily followed "map", the new television demonstrator has 200 plug-in parts which permit most of the components such as resistors, capacitors, and tubes to be readily removed from the panel. This permits any service condition that might occur in any part of a television receiver to be simulated, or the effect of off-value components to be graphically demonstrated. Since these conditions register on the viewing screen of a picture tube as "no picture", "interference" and other forms of distortion, "trouble patterns" may be quickly recognized and classified.



The demonstrator is constructed so that the individual panels may be completely detached from the main panel and operated "alive" by means of a power supply, if desired.

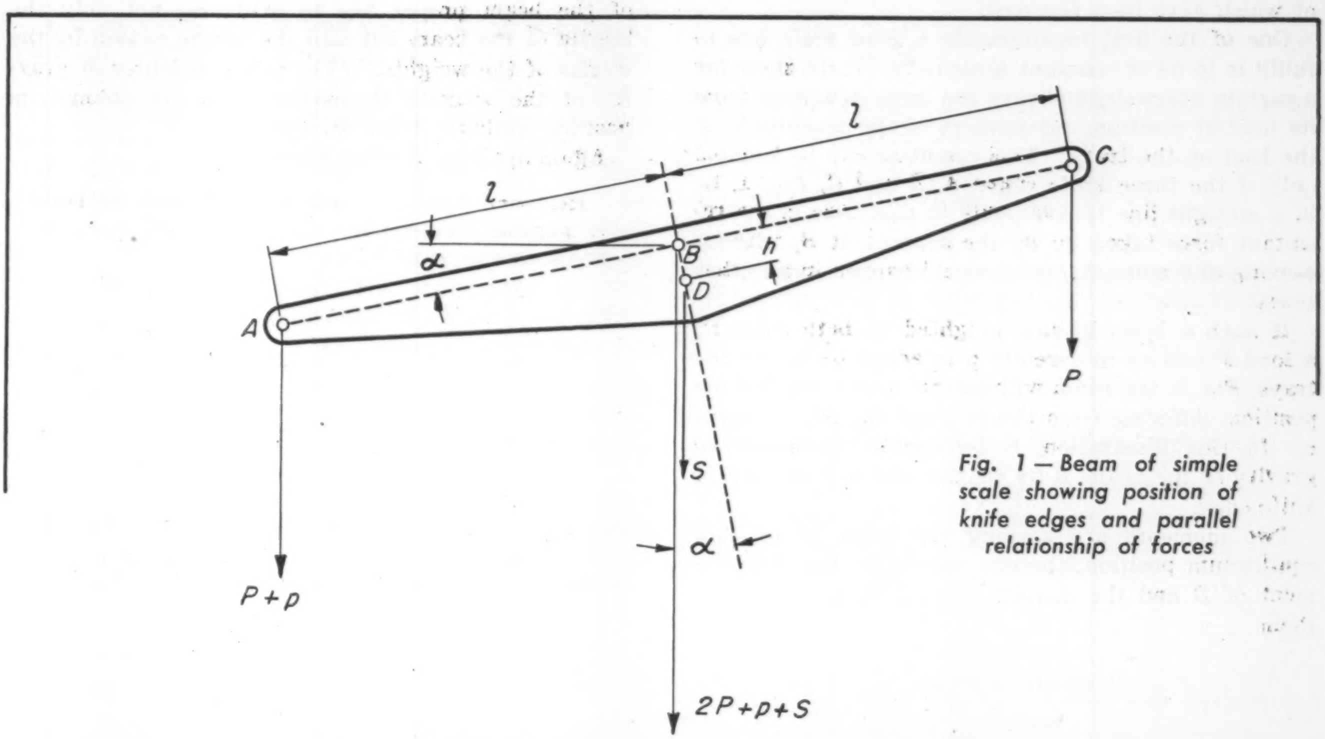


Fig. 1 — Beam of simple scale showing position of knife edges and parallel relationship of forces

Design of Beam Scales

By Sigmund Rappaport
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FEATURES of greatest interest in the performance of a beam scale are (apart from its capacity and accuracy) its sensitivity and the time required for a full oscillation. It is this time that determines the speed at which the scale can be operated; a point especially important in automatic weighing machines.

It would be desirable of course to combine the shortest possible oscillation time with the highest possible sensitivity. But these two are not independent of each other. This article will show the laws governing the connection between oscillation time and sensitivity of the ordinary beam scale.

From basic physics it will be recalled that the period of a pendulum may be shown as

$$T = 2\pi \sqrt{\frac{K}{Sh}} \qquad (1)$$

Where T is the time required for a complete oscillation, K is the moment of inertia with respect to the pivot point, h is distance from the pivot to the center of gravity, and S is weight of the pendulum. It follows that the period decreases if h increases. This same formula will apply to a scale-beam, the trays

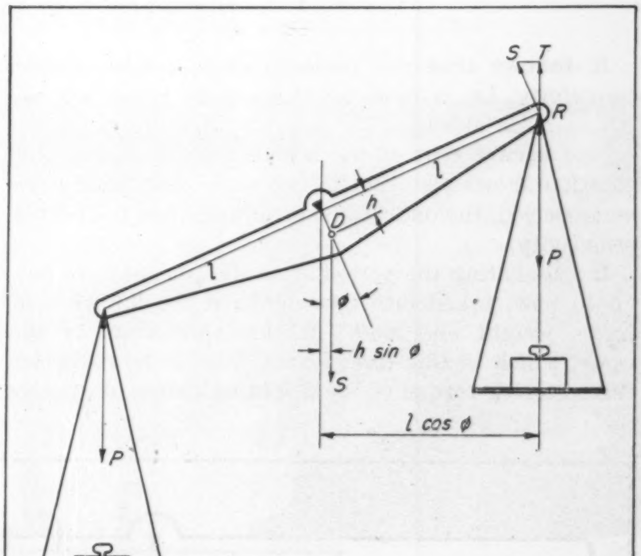


Fig. 2—Effect of adding pan load to scale beam. RS is tangential acceleration and RT is vertical component of tangential acceleration

of which have been removed.

One of the first requirements a good scale has to fulfill is to be of constant sensitivity, i.e., to show for a certain overweight always the same deviation from its neutral position, independent of the magnitude of the load on the trays. This condition can be fulfilled only if the three knife edges *A, B* and *C, Fig.* 1, lie in a straight line because only in that case is the resultant force taken up by the support at *B,* without causing any moment, which would happen in all other cases.

If such a beam is now weighted on both sides by a load *P* and an overweight *p* is added to one of the trays, *Fig.* 1, the beam will assume a new equilibrium position, differing from the original one by the angle *α*. In this illustration, *D* represents the center of gravity of the beam, *S* its weight, and *B* is the center knife edge.

Two moments are keeping the beam in its new equilibrium position, the one caused by the displacement of *D* and the moment caused by *p*. Equating them

$$Sh \sin\alpha = pl \cos\alpha$$

$$\tan\alpha = \frac{pl}{Sh}$$

From this, the value (tangent of angle of deflection) ÷ (overweight) may be taken as measure for the sensitivity and called *z,* then

$$z = \frac{\tan\alpha}{p} = \frac{l}{Sh} \quad \text{.............................} \quad (2)$$

which formula shows that in order to achieve a high sensitivity it is necessary to make the beam long, but light, and to make *h* short. Combining Equations 1 and 2

$$T = 2\pi\sqrt{\frac{Kz}{l}}$$

It follows that the period increases with higher sensitivity, i.e., a more sensitive scale beam will oscillate more slowly. The period will be proportional to the square root of the sensitivity. A simple calculation shows also that if two scale beams have the same period, the one with shorter arms has the higher sensitivity.

In calculating the period of oscillation we have not, up to now, taken into consideration the influence of trays, weight and load. If the equilibrium of the scale, which is this time loaded, *Fig.* 2, is disturbed, the restoring torque of the displaced center of gravity of the beam proper has to overcome not only the inertia of the beam but also the torque caused by the inertia of the weights. (The common center of gravity of the weights themselves does not change its position while the beam oscillates.)

Again applying Newton's law

> Restoring torque = moment of inertia of beam × angular acceleration + resisting torque, caused by the inertia of 2*P*

and

$$Sh \sin\phi = K\frac{d^2\phi}{dt^2} + \frac{2P}{g}\,l\,\frac{d^2\phi}{dt^2}\cos\phi\,(l\cos\phi)$$

$$Sh \sin\phi = K\frac{d^2\phi}{dt^2} + \frac{2P}{g}\,l^2\cos^2\phi\,\frac{d^2\phi}{dt^2}$$

For small angles $\cos^2\phi$ can be replaced by 1. This will result in an error in the final equation of the order of ½ per cent if ϕ is less than 8 degrees.

$$Sh \sin\phi = \frac{d^2\phi}{dt^2}\left(K + \frac{2P}{g}\,l^2\right)$$

$$\frac{d^2\phi}{dt^2} = \frac{Sh \sin\phi}{K + \frac{2P}{g}\,l^2} \quad \text{..........................} \quad (3)$$

Equating Equation 3 with the basic formula for acceleration of a point-pendulum and combining with the basic period equation

$$T = 2\pi\sqrt{\frac{K + \frac{2P}{g}\,l^2}{Sh}} \quad \text{..........................} \quad (4)$$

From Equations 2 and 4, the connection and interaction of oscillating time and sensitivity is found as follows:

$$z = \frac{l}{Sh}$$

$$Sh = \frac{l}{z}$$

$$T = 2\pi\sqrt{\frac{zK + z\frac{2P}{g}\,l^2}{l}}$$

or

$$T = \frac{2\pi}{\sqrt{g}}\sqrt{\frac{zKg + 2zPl^2}{l}} \quad \text{..........................} \quad (5)$$

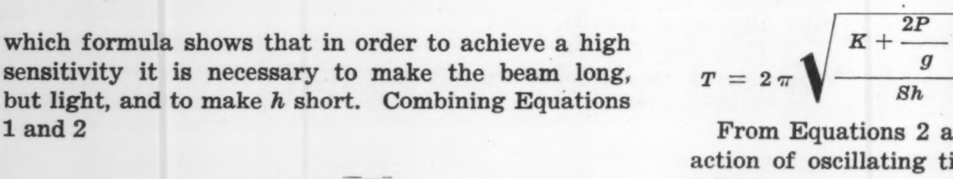


Fig. 3—Center of gravity of beam may be found by adding simple geometric mass of known properties. D is unknown center of gravity of beam, C is known center of gravity of added mass, and D_1 is the center of gravity of the system

The foregoing calculations contain as an important part the moment of inertia, *K,* of a scale beam and the location of its center of gravity. These values are not always easily determined, especially if the beam is not of the simplest geometrical design. In order to obtain these values in a simple manner, the following method is useful.

A geometrically-simple, small piece of known weight *W, Fig.* 3, is clamped symmetrically to the vertical center line of the beam. The dimensions of this piece being known, the location of its center of gravity, *C,* and its moment of inertia, *J,* with reference to *C* can be calculated.

Then the moment of inertia, K_1, of the thus-changed scale beam, is:

$$K_1 = K + J + \frac{W}{g}(m - n)^2 \quad \ldots\ldots (6)$$

Calling

$$J + \frac{W}{g}(m - n)^2 = A$$

Equation 5 reduces to

$$K_1 = K + A \quad \ldots\ldots (7)$$

The weight of the changed beam is

$$S_1 = S + W \quad \ldots\ldots (8)$$

Its new common center of gravity, D_1, will be located at the distance h_1, which is calculated from the law of moments

$$Sh + W(m - n) = (S + W)\,h_1$$

and

$$h_1 = \frac{Sh + W(m - n)}{S + W} \quad \ldots\ldots (9)$$

The oscillation time, *T,* of the beam without the added piece is noted, from Equation 1, to be

$$2\pi\sqrt{\frac{K}{Sh}} = T$$

In addition the oscillation time, T_1, of the beam onto which the piece was clamped may be found to be

$$2\pi\sqrt{\frac{K_1}{S_1 h_1}} = T_1 \quad \ldots\ldots (10)$$

Substituting Equations 7, 8 and 9 in Equation 10

$$T_1 = 2\pi\sqrt{\frac{K + A}{(S + W)\,\dfrac{Sh + W(m - n)}{S + W}}} =$$

$$2\pi\sqrt{\frac{K + A}{Sh + W(m - n)}} \quad \ldots\ldots (11)$$

From Equations 1 and 11 the only two unknowns *h* and *K* are found

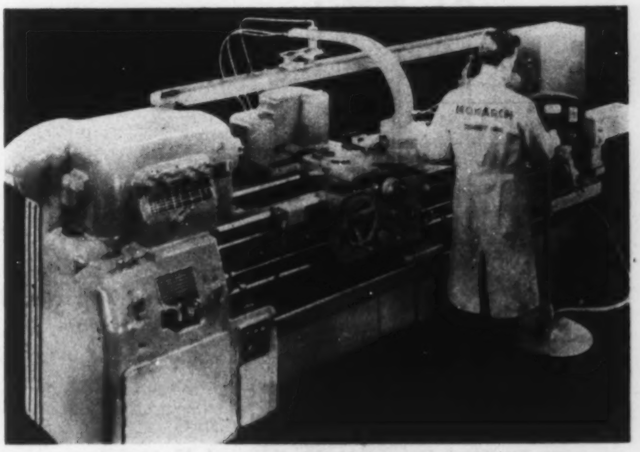
$$h = \frac{4A\pi^2 - T_1^2 W(m - n)}{S(T_1^2 - T^2)}$$

$$K = \frac{T^2}{T_1^2 - T^2}\left[A - \frac{T_1^2 W(m - n)}{4\pi^2}\right]$$

The foregoing method has been employed successfully. The test results obtained from experiment were in accordance with the theoretically calculated data within the limits of the error of observation.

Lathe Tracer Accessory

PROVIDING a combination of the features of a modern flexible engine lathe and high production economies of automatic cycling, together with template control of size and contour, the lathe attachment shown is a recent refinement of a model originally developed by the Monarch Tool Co. several years ago. The "air-gage tracer-packaged unit" provides an individual motor drive for the lathe carriage feed which, when used with the tracer, provides for easy selection of the exact feed suited to any particular job and also permits automatic cycling. Since the operator has only to load and unload the machine, he can attend two or more machines with no loss in the quality of the work.



An electronically controlled motor drive coupled to the right end of the leadscrew provides stepless variation of the carriage feed rate in a range of ½ to 20 inches per minute. Selection of the feed desired is made on an indicator on the portable control panel, the indicator at the same time providing a visual check of the feed being used. The start of the carriage feed in the required relationship to the tracer cross-fed is accurately timed with an interval timer. In providing template control of size and shape the tracer effectively eliminates repetitive measurements, expensive form tools and multiple tool setups.

Key Factors in Cam Design and Application

By John A. Hrones
Professor of Mechanical Engineering
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Part III—Followers and Follower Systems

CAM FOLLOWERS are of two basic types: Those in which a rolling element is used to transfer motion from the cam and those in which no effort is made to reduce the amount of sliding between the cam and its follower. In the latter category fall the pointed, the flat, and the curved surface follower (*Figs.* 1, 24, 25).

The pointed follower is rarely used because of its obviously poor wearing properties and the high cam stresses which it causes. Flat and curved-surface followers are widely used. They can be employed (with few exceptions) only with open type cams. In general they must be spring loaded against the cam surface. Because of the large radius of curvature of the follower surface they provide a favorable contact stress condition. In addition, this type of follower usually can be made lighter than a corresponding roller follower. Such advantages are often partially or wholly offset by the higher force level introduced by the spring and the presence of sliding under high stress at the points of contact. Adequate lubrication must be provided to prevent excessive localized temperatures which would cause surface failure. Valve-cam followers in many internal combustion engines are of this type. In such applications the total follower load is the sum of the spring forces and the inertia force of the valve. Space requirements are critical; lubrication is adequate. The importance of light weight and small size make the flat or curved-face follower a satisfactory solution.

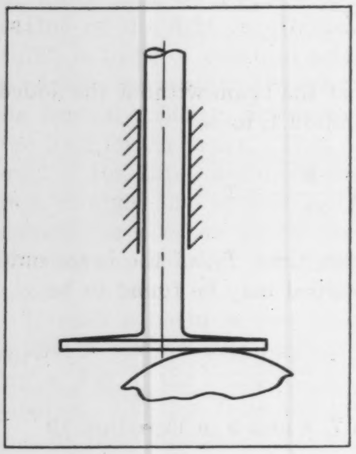


Fig. 24—Top — Flat-faced follower

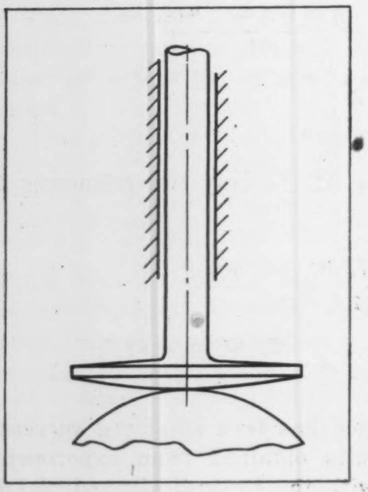


Fig. 25 — Center — Curved surface follower

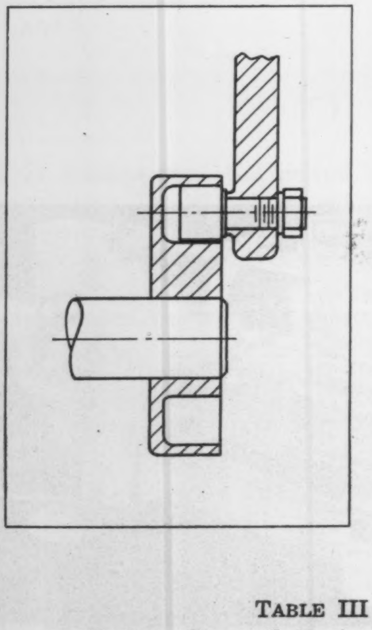


Fig. 26—Left—Roller follower with closed type cam

Roller followers, *Fig.* 26, are widely used with both open and closed type cams. When properly designed they eliminate sliding action at the cam surface, and the small roller radius permits great flexibility in cam contour design. Roller followers are in almost universal use on closed cams. On a closed type cam which provides a positive drive in both directions, extreme care must be exercised to avoid excessive clearance in the cam track because such clearance results in impact loads on the surface when load reversal occurs. If no clearance between the roller and cam is provided slip must of necessity occur at one or both surfaces. Upon load reversal with clearance present the roller must quickly reverse its direction of motion. The possibility of slip and the neces-

TABLE III

Fatigue Strength Factors of Materials

Roller Material	Cam Surface Material	C Factor
Hardened steel (500 Bhn)	Cast iron	1000
Hardened steel (500 Bhn)	Nickel cast iron	2000
Hardened steel (500 Bhn)	No. 65 Phosphor bronze	1200
Hardened steel (500 Bhn)	SAE 6150 (300 Bhn)	1500
Case-hardened steel (min. case—0.06-in.)	Case-hardened steel (min. case—0.06-in.)	6000

sity of roller reversal is eliminated if the double roller assembly shown in *Fig.* 27 is used. The overhung roller assembly often leads to appreciable deflection in the follower. Where necessary, some compensation for estimated deflections in the follower system can be made in the cam contour design. In most internal combustion engine valve gear such compensation is made.

Design of the follower system is extremely important as it greatly influences the operation and life of the overall system. The following points should be kept in mind:

1. Hold play and backlash at a minimum
2. Make all elements as stiff as possible
3. Make all follower components as light as possible consistent with adequate stiffness
4. Lubricate all bearings and contact surfaces.

STRESS DETERMINATION: Stresses produced at the surface of contact, σ_c, may be estimated from the Hertz equation

$$\sigma_c^2 = \frac{F}{t}\,\frac{\left(\dfrac{1}{\rho_{min}} + \dfrac{1}{\rho_r}\right)}{\left(\dfrac{1}{E_c} + \dfrac{1}{E_r}\right)} \qquad (22)$$

Where F = load between surfaces, pounds; t = thickness of cam or width of roller, inches; σ_{min} = minimum radius of curvature of cam profile, inches; σ_r = radius of roller, inches; E_c and E_r = modulus of elasticity of cam and roller, respectively, pounds per square inch.

Numerous tests have been conducted to determine the values of σ_c for which a given pair of materials will have satisfactory wear life. Fatigue strengths so determined are the basis for estimating the load which a cam and its follower may sustain without excessive wear.

Equation 22 may be rewritten

$$F = \frac{\sigma_c^2 t\left(\dfrac{1}{E_c} + \dfrac{1}{E_r}\right)}{\left(\dfrac{1}{\rho_{min}} + \dfrac{1}{\rho_r}\right)}$$

Let σ_{ec} = the value of σ_c which will give substantially infinite wear life. Then $C = \sigma_{ec}^2(1/E_c + 1/E_r)$ is a factor which describes the fatigue strength of two materials when operated together under conditions of rolling and sliding. The values of C for a number of widely used cam and follower materials are listed in TABLE III.

Maximum allowable load normal to the surface of the cam consistent with infinite life is given by:

$$F = \frac{Ct}{\left(\dfrac{1}{\rho_{min}} + \dfrac{1}{\rho_r}\right)} \qquad (23)$$

The value of F determined from Equation 23 is that corresponding to the peak dynamic force acting on the cam (see previous analysis). Where a spring is used to hold the follower on the cam surface the entire force level on the elements is substantially increased, thereby increasing the required torque and stresses in the cam. This may be seen readily by studying *Fig.* 28. The importance of providing a spring with a low rate to achieve minimum peak forces is evident. Such a desirable design is often discarded because of the pressing requirements of limited space.

FOLLOWER SPRING: In order to keep the increase in the cam forces inherent in the use of a spring at a minimum it is desirable, as indicated in the foregoing to use a low rate spring. Referring to *Fig.* 28

$$F_1 = cF_p - kx_1$$

$$F_3 = cF_p + kx_2$$

$$F_3 - F_1 = k(x_1 + x_2) = kL$$

where F_1 = minimum spring force; F_3 = maximum spring force; f_p = peak follower force tending to lift follower from cam surface with no spring present; and $c = F_2/F_p$.

As it requires a finite time for a net force to produce a displacement, the coefficient c can be shaded to a value something less than one without serious difficulty. Space limitation is not the only restriction on the selection of a cam spring. Care must be exercised to insure that operating speed of the cam will not excite one of the natural frequencies of the spring and thus promote an early fatigue failure of the spring. The lowest natural frequency of the spring may be determined from the following relations.

For fixed-ended springs:

$$f = \frac{md}{4\pi D^2 m}\sqrt{\frac{2Gg}{v}} \text{ cycles per second}$$

m = Mode of vibration (m = 1 gives lowest natural frequency)
d = Wire diameter, inches
D = Mean coil diameter, inches
n = Number of coils
G = Modulus of rigidity (pounds per square inch) (for steel, $G = 11.5 \times 10^6$ psi)
g = Gravitational constant (386 inches per second^2)

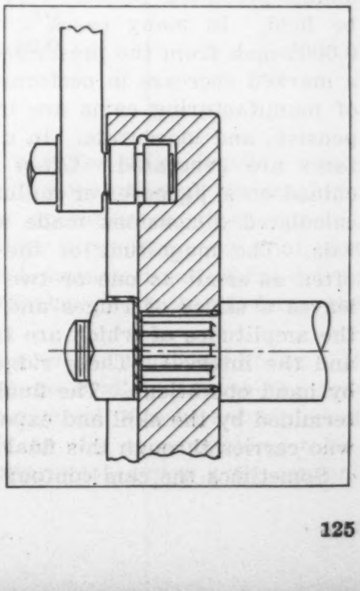


Fig. 27 — Double-track cam with double-roller follower

ν = Density of spring material (pounds per cubic inch) (for steel ν = 0.285 pound per cubic inch.)

As the spring in any event is subjected to alternating stresses, all sources of stress concentration should be avoided and care exercised in specifying the material, heat treatment, and surface finish of the spring.

Driver System: In many cases the speed of operation of a cam-driven system can be increased by a reduction in weight of the driven member. Use of aluminum in designs where all needless material is eliminated can result in improved dynamic performance.

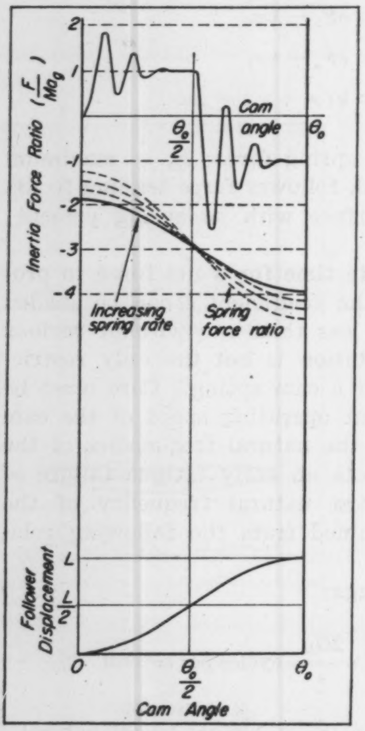


Fig. 28 — Inertia force, spring force and displacement plotted against cam angle, for constant-acceleration cam

Importance of Cam Contour Accuracy: Relatively small changes in the cam contour will result in vastly different dynamic performances. In order to obtain predicted results, very close tolerances must be held. In many cases a variation of less than 0.0005-inch from the prescribed contour will result in a marked decrease in performance. Present methods of manufacturing cams are in many cases slow, expensive, and inaccurate. In a few instances the surfaces are generated. Often a master cam is machined on a jig borer or milling machine to carefully calculated dimensions made at equal angular intervals. The magnitude of the interval varies but is often as small as one or two degrees. This process leaves a series of ridges and valleys in the contour the amplitudes of which are functions of the contour and the interval. These ridges are usually removed by hand operations. The final result is therefore determined by the skill and experience of the individual who carries through this final operation.

Sometimes the cam contour is first carefully cut in a relatively thin metal blank called a "leader." The leader is then used as a master to produce the cams directly if only a few are required. If large numbers of cams are required, the leader is used as the form from which the master cam is duplicated. The leader or the master is then used to position continuously the cutting tool which produces the contour of the production cams. Production cams will be a faithful reproduction of the desired outline only if all of the steps outlined in the foregoing are executed with extreme care and precision. Even under favorable conditions the results are often disappointing. Initial calculations and their reproduction in the settings of the machine used to cut the master or the leader are both subject to human error and are limited in accuracy. Deflections in the equipment employed to make production cams from the master are an additional serious source of trouble. These troubles can be reduced to a minimum by careful design and control. At best, however, our present methods of cam manufacture do not seem to offer attractive opportunities for significant advances in accuracy and precision.

Modern developments in computing machines, in servomechanisms, and machine tool design appear to offer another approach to this problem. It is possible to visualize a cam-generating machine consisting of a computing machine supplying data direct to a servomechanism which automatically positions a continuously moving cutting tool which machines the production cams. In such a machine a fast measuring instrument might be continuously measuring the outline in process and readjusting tool position, thus eliminating errors due to deflections in the equipment. Basic information would be supplied to the calculating machine on a punched tape or by other methods now in wide usage. A number of steps have been taken in this direction and it may well be that in the near future the engineer can demand and get precision cams in large numbers as he now can obtain precision gears.

"OH MR. CYPHUR, WILL YOU PLEASE ADD UP THESE FIGURES ON YOUR SLIDE RULE?"

WHICH fractional-horsepower motor?

Considerations in selecting motor drives to fit the job

By M. C. Lindsten
Motor Application Engineer
Bodine Electric Co.
Chicago

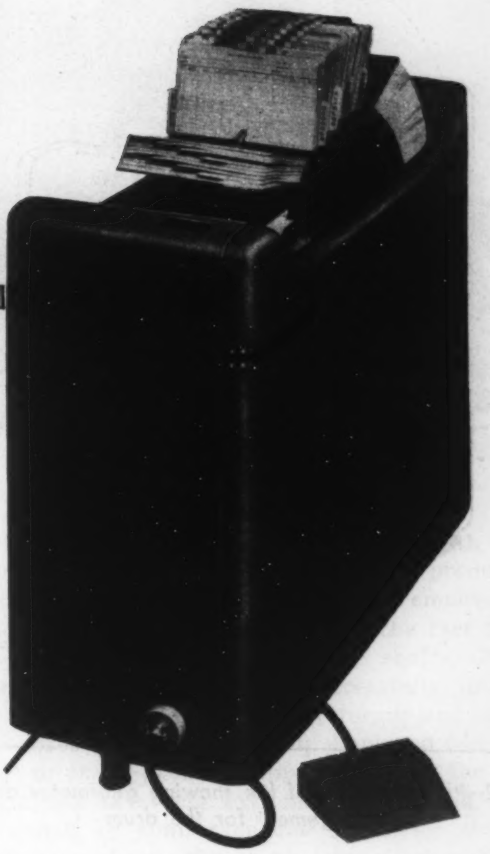


Fig. 1—Rotary card file. Drum holding index cards is motor driven by reversing-duty capacitor motor having a high resistance rotor and built-in worm-gear reducer

FOREMOST consideration in the selection of a motor drive for any application is the electric power supply available for operation of the machine. Provisions must be made in some cases for operation on direct current, and on various off-standard voltages and frequencies, dependent upon what part of the globe the appliance has its market. The load characteristics of the driven machine and the performance characteristics of the motor itself form the underlying basis for selection.

Required operating speed and direction of rotation must be known. If the machine is to be reversed, information must be available as to the frequency of reversal anticipated, and as to whether reversal is to be accomplished from standstill or while running. As indicated in the accompanying table, certain motors, including split-phase and capacitor-start types with conven-

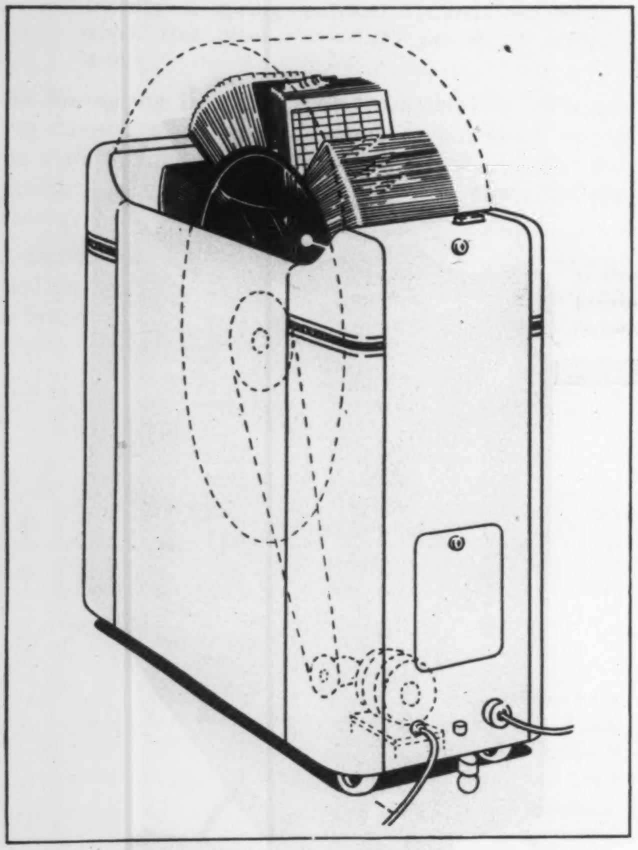


Fig. 2—Phantom view of file showing gearmotor drive arrangement for the drum

tional centrifugal starting switches, cannot be reversed from full speed in one direction. Capacitor start-and-run motors, direct-current shunt-wound motors and polyphase motors, on the other hand, can readily be reversed while running.

Torque or turning effort is another important consideration and is a measurement of the pull a motor will exert at a given radius, regardless of whether the shaft turns or not. This factor should not be confused with horsepower, which is an expression of the amount of work a motor can do in a given period of time. Torque required to start a given load can usually be measured with a simple pulley, string, and spring balance. The measured torque is the product of the pulley radius and the force applied to the string to cause the load to rotate. Care must be taken in this test to measure the starting torque at a point in the operating cycle which offers the greatest resistance to rotation. The torque to operate a given machine can vary over the operating cycle, and may not necessarily be greatest at the start of an operating cycle.

Temperature Limitations on Motors

Temperature considerations must of necessity enter into any motor selection. Theoretically, any motor is capable of carrying loads in excess of its rated capacity. Additional power may be obtained merely by loading the motor beyond the horsepower rating established by the manufacturer. Under these conditions, however, the temperature limits of the motor are likely to be exceeded. At the present time, the National Electrical Manufacturers Association has established 40 C as the maximum allowable rise for a ventilated or open-frame motor, and 55 C as the maximum allowable rise for a standard totally-enclosed motor.

Loading a motor beyond capacity may also cause its speed to drop below its rated value. This, of course, might be objectionable in many applications. Speeds of series-wound motors are particularly affected by changes in load.

Duty Cycle Should Be Known

The duty cycle is also of vital importance and refers to the time the motor will be in operation as compared to the time it will be at rest. With the exception of the series type, motors are usually rated for continuous-duty service, but can generally be rated somewhat higher for intermittent duty. In selecting a motor for a specific application, the most adverse duty conditions should be known. If the load is too great, and the running period too long, the motor may overheat. This condition will result in gradual deterioration of the windings and in ultimate motor failure.

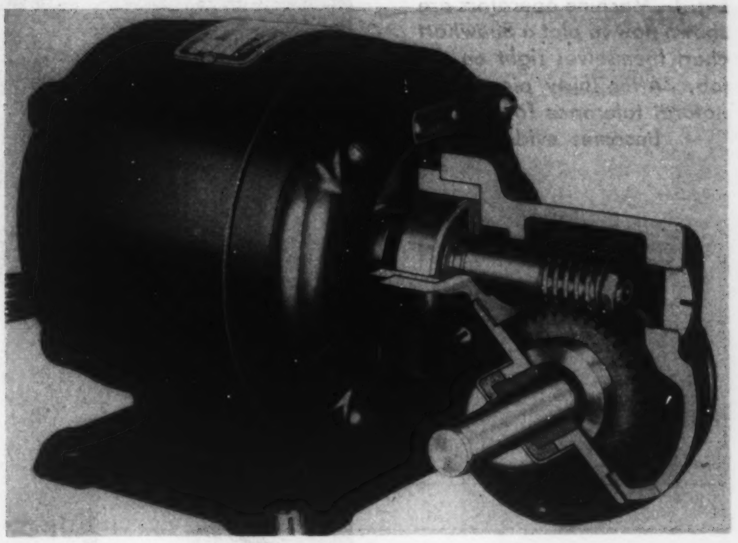
Correct lubrication is essential to trouble-free

Features of Fractional Horsepower Reversing Motors*

Operating Features and Requirements	Induction Type Reversing Motor								Brush Type Reversing Motor				
			Capacitor Start and Run										
	Split-Phase		Nonsynch.		Synch.		Multiphase		Shunt Motor		Compound Motor	Series Motor	
	Non-Synch.	Synch.	4-Lead Rev.	3-Lead Rev.	4-Lead Rev.	3-Lead Rev.	Non-Synch.	Synch.	Full Field	Split-Field	5-Lead Reversible	4-Lead Rev.	3-Lead Rev.
Suitable for reversing at rest only	X	X											
Suitable for reversing during rotation or at rest			X	X	X	X	X	X	X	X	X	X	X
Double-pole double-throw switch required	X	X	X		X		X	X	X		X	X	
Single-pole double-throw switch sufficient				X		X				X			X
Running characteristics slightly affected by best obtainable instantaneous reversing characteristics			X	X	X		X	X	X		X	X	
Running characteristics greatly affected by best obtainable instantaneous reversing characteristics						X				X			X

* Sizes from 1/200 to ¼ horsepower.

Fig. 3—Cutaway view of built-in worm-gear reducer on drive. Motor is a capacitor start-and-run type having a special high resistance rotor for increasing starting torque



operation and prolonged motor life. This is especially true of low-power motors. An oil having too high a viscosity can cause high internal friction which will detract from the available power of the motor. Temperature considerations also play an important part in this respect, since lubricant viscosities vary considerably with changes in temperature. A variety of special lubricants is available for applications requiring operation in abnormally high or low ambient temperatures.

Thus far in this presentation, application considerations have been confined to motors without built-in speed reducers. In the last decade, electric motors with integral speed reducers have become increasingly popular among manufacturers of small motor-driven machines. By combining the motor and speed reducer in one unit, all cumbersome and complicated speed reducer transmissions are eliminated. This relieves the equipment manufacturer of many of the design engineering problems formerly encountered in obtaining reduced speeds for certain applications, and places the responsibility directly with the motor manufacturer.

Reducer motors are selected not on the basis of motor horsepower rating, but on speed and output torque at the final drive shaft. The required motor horsepower output is calculated on the basis of the maximum torque required, the speed of the driven load, the efficiency of the gear train and the speed of the motor itself. As will be seen, the latter factor is dependent upon the basic operating speed of the specific motor chosen for the application. The value of horsepower required in the case of a gear reducer motor can be determined from the following relationship:

$$\text{HP} = \frac{TN\ (9.93)\ 10^{-7}}{RE}$$

where: T = torque in oz-in. at slow shaft, N = rpm of motor, R = gear ratio, and E = overall gear efficiency.

In selecting the gear ratio, the application engineer must give due regard to the strength of the gears and also their adaptability for the application intended. Care must be taken that the maximum torque loading encountered does not exceed the rated strength of the gears. This factor is normally calculated on an empirical basis, and takes both wear and shear strength into consideration. For certain applications, where the duty service is of an intermittent nature, the rated strength can sometimes be exceeded slightly.

Where low reduction ratios and low torques are involved, most gear reducers employ laminated-phenolic gears because of their quiet operation and excellent wearing qualities. Reducers equipped with grease lubricated plastic gears can usually be produced on a more economical basis than those employing oil lubricated bronze gears, in view of the fact that no oil seals are required at the drive shafts. In some cases, bronze gears may be successfully lubricated with grease, depending upon the torque and the duty cycle. Bronze gears are usually employed where high torque or shock loads are encountered. In the case of applications involving extreme shock loads, a friction clutch or similar cushioning device should be installed to absorb the shock impact when the load is applied.

Restrictions on Worm Gears

In applying worm-gear speed reducers, high-inertia loads must not be coupled direct to the reducer drive shaft, since the momentum of the load may damage the gears. Similarly, worm-gear reducers should not be used in applications involving loads which are likely to lock. Whenever possible, an application involving either a high inertia or a locking load should include a form of safety clutch or shear pin between the reducer drive shaft and the driven load.

Economics must be given due consideration in any motor selection, and it is generally well to avoid design complexity and special features whenever possible. This is particularly true where small quantities are involved, and in these cases consideration should be given, when feasible, to use of standard motors. Where large volume production is anticipated, however, tooling costs and other expenses can be amortized over a larger number of units. In this event, is may be found economically feasible to consider special design features.

The rotary card file illustrated in ***Fig.*** **1** is an excellent example of the multiplicity of engineering considerations that can enter into a single application problem. The Cardineer, as the file is known, is designed to facilitate handling of office record cards. Operation is controlled by a simple two-way hand button or foot pedal switch. Records may be revolved

(Continued on Page 156)

Fig. 1—Machine operators are shown how to plot a Shewhart chart themselves right on the job. After thirty pieces, the natural tolerance for the job becomes evident

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Interchangeable Tolerances—Arbitrary

On parts to be produced under statistical control the designer can obtain assembled tolerances with components whose individual tolerances add algebraically to a far greater figure. In this article, based on a paper presented at the recent SAE annual meeting in Detroit, the author presents two unusual charts which simplify the selection of component tolerances with due regard to natural process variations

FOR a long time engineers have performed additions in their calculations according to the style of two plus two equals four. Under certain circumstances which are currently coming into vogue in manufacturing practices, however, two plus two can equal 2.83. The circumstances, becoming increasingly popular in all forms of manufacturing activity, which can make possible this economical type of addition are classified under the heading, "The application of statistical quality control." With this application also must be present the requirement for two or more component parts, batches, or what have you, to be assembled to give a desired end product.

The branch of statistical quality control concerned is the application of the Shewhart type control chart to fabricating operations, *Fig.* 1. This chart serves as an extra tool for the operator, a tool that has the happy faculty of being able to get the "most" out of a process or operation by reducing the variation of its measured and desired resultant characteristic to a practical minimum "least".

Revealed to the operator by the chart is the presence of any cause of variation that is not constantly inherent in the fabricating process—be it man, ma-

Fig. 2—Right—Natural chance distribution of size or other quality characteristics versus frequency of occurrence results in this typical curve

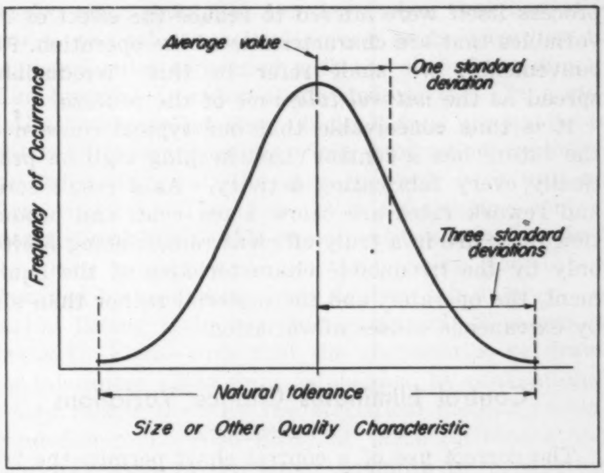
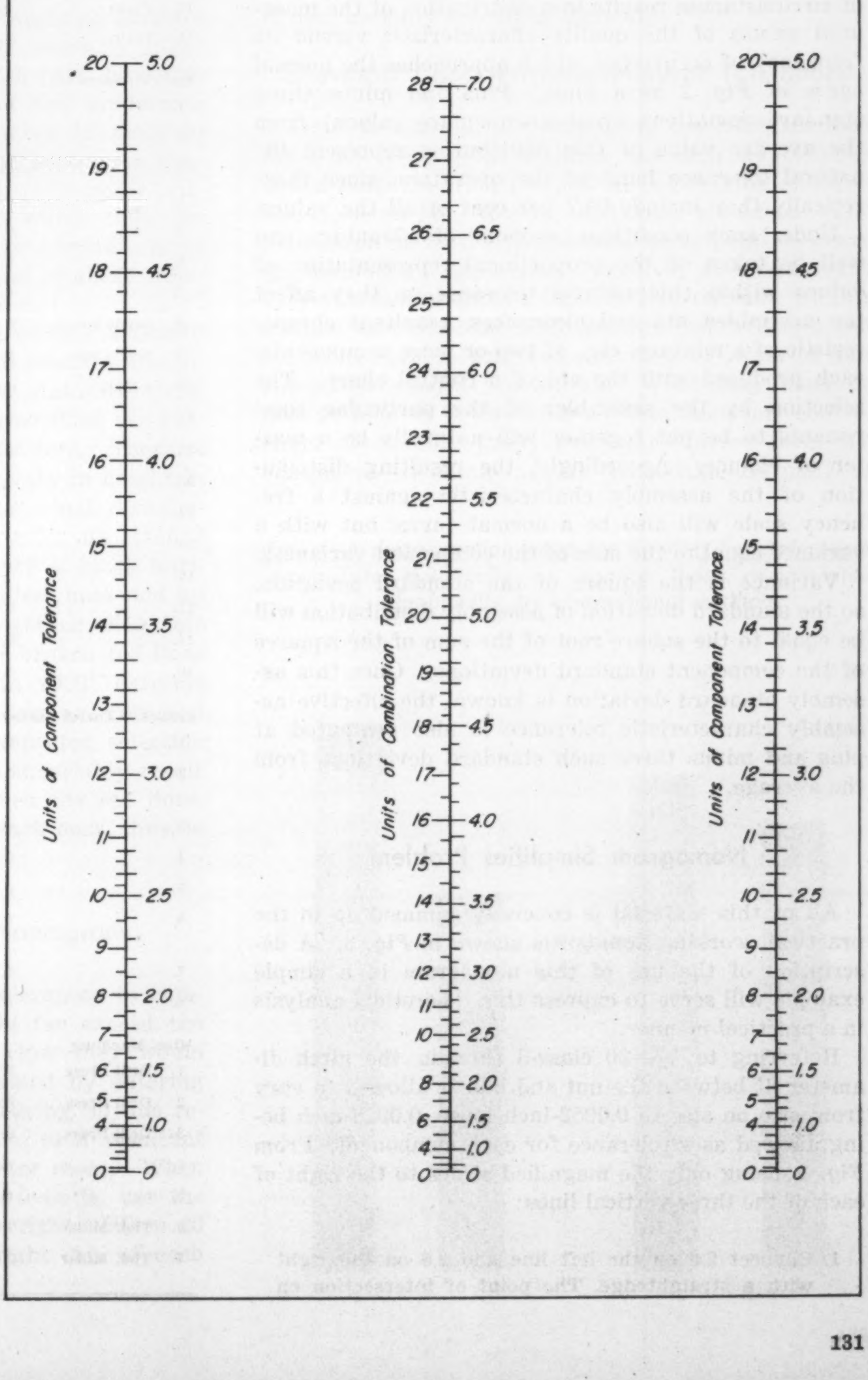


Fig. 3—Below—Practical working nomogram for determining the assembled tolerance for any two component tolerances

or Natural?


Units of Component Tolerance
20 5.0
19
18 4.5
17
16 4.0
15
14 3.5
13
12 3.0
11
10 2.5
9
8 2.0
7
6 1.5
5
4 1.0
0 0
Units of Combination Tolerance
28 7.0
27
26 6.5
25
24 6.0
23
22 5.5
21
20 5.0
19
18 4.5
17
16 4.0
15
14 3.5
13
12 3.0
11
10 2.5
9
8 2.0
7
6 1.5
5
4 1.0
0 0
Units of Component Tolerance
20 5.0
19
18 4.5
17
16 4.0
15
14 3.5
13
12 3.0
11
10 2.5
9
8 2.0
7
6 1.5
5
4 1.0
0 0

chine, or material. With such a chart a worker becomes rapidly proficient at recognizing each specific extraneous cause of variation, and thus by eliminating it he maintains the effective total variation at a spread of values established by the chance combination of the inherent variables. A further reduction of this dispersion would be generally impractical unles the basic

process itself were altered to reduce the effect of the variables that are characteristic of the operation. For convenience, we shall refer to this "irreducible" spread as the *natural tolerance* of the process.

It is thus conceivable that our typical concern of the future has a control chart keeping vigil on practically every fabricating activity. As a result scrap and rework rates are below 1 per cent, and production rates are in a truly efficient range; being limited only by the irreducible characteristics of the equipment, the operator, and the material rather than also by extraneous causes of variation.

Control Eliminates Chance Variations

The correct use of a control chart permits the free action of only those variables truly inherent to the process. They combine at the particular values they may have at any moment purely by chance. This set of circumstances results in a distribution of the measured values of the quality characteristic versus its frequency of occurrence which approaches the normal curve of *Fig.* 2 as a limit. Plus and minus three standard deviations (root-mean-square values) from the average value of this distribution represent the natural tolerance band of the operation, since theoretically they include 99.7 per cent of all the values.

Under such conditions, economical advantage can well be taken of the proportional representation of values within this natural tolerance as they affect the assembled fits and clearances, resultant characteristic of a mixture, etc., of two or more components, each produced with the aid of a control chart. The selection by the assembler of the particular components to be put together will naturally be a matter of chance. Accordingly, the resulting distribution of the assembly characteristic against a frequency scale will also be a normal curve, but with a variance equal to the sum of the component variances.

Variance is the square of the standard deviation, so the standard deviation of assembly distribution will be equal to the square root of the sum of the squares of the component standard deviations. Once this assembly standard deviation is known, the effective assembly characteristic tolerance is also computed at plus and minus three such standard deviations from the average.

Nomogram Simplifies Problem

All of this material is concisely summed up in the practical, working nomogram shown in *Fig.* 3. A description of the use of this nomogram in a simple example will serve to express this theoretical analysis in a practical manner.

Referring to ½—20 class-3 threads, the pitch diameter fit between the nut and bolt is allowed to vary from size on size to 0.0052-inch loose, 0.0026-inch being allowed as a tolerance for each component. From *Fig.* 3, using only the magnified scales to the right of each of the three vertical lines:

1. Connect 2.6 on the left line and 2.6 on the right with a straightedge. The point of intersection on

TABLE I

Natural Machine Tolerances

(inches)

Machine	Natural Tolerance	Drawing Specifications
Ext. Grinders		
1. Universal	0.00048	4.288/4.289 diam of groove
2. Plain	0.00634	0.165/0.180 face step
3. Plain	0.0007	5.875 (+0.000 –0.001) OD boss
4. Plain	0.0008	5.875 (+0.000 –0.001) OD boss
5. Plain	0.00094	4.4999 (+0.000 –0.0013) diam
6. Plain	0.00098	4.9061 (+0.000 –0.0013) diam
7. Plain	0.00094	7.1873 (+0.000 –0.001) diam
8. Plain	0.0026	0.375 (+0.005 –0.000) flange thick.
9. Plain	0.00094	4.4999 (+0.000 –0.0013) diam
10. Plain	0.00098	4.9061 (+0.000 –0.0013) diam
11. Plain	0.00078	5.4998 (+0.000 –0.001) diam
12. Plain	0.00088	6.0935 (+0.000 –0.001) diam
13. Plain	0.00084	6.3748 (+0.000 –0.001) diam
14. Plain	0.00078	7.1873 (+0.000 –0.001) diam
Int. Grinders		
1.	0.00048	3.877/3.875 ID bore
2.	0.00072	4.813/4.820 ID bore
3.	0.00091	8.5007 (± 0.0005) ID
4.	0.00077	5.3757 (±0.0005) ID
5.	0.00173	7.599 (±0.001) ID
6.	0.00084	5.7819 (±0.0005) ID
7.	0.00177	8.469 (±0.001) ID
8. single lobe	0.00128	1.381/1.393 width of track
9. single lobe	0.00457	1.381/1.393 width of track
10. 4 lobe	0.0084	1.631/1.643 width of track
11.	0.0014	0.625 (+0.0005 –0.001) ID lug hole
12.	0.00144	1.631/1.643 width of track
13.	0.00234	1.881/1.893 width of track
14.	0.003	7.260/7.250 ID arm bore
15.	0.0016	6.381/6.373 centerline to thrust face
16.	0.00198	6.755/6.750 ID cross bore
17.	0.0027	11.515/11.485 ID dome shelf
18.	0.00114	11.6925/11.6825 ID dome shelf
19.	0.0025	11.766/11.751 thd. bore diam
Lathes & Turret Lathes		
1.	0.0024	8.675/8.680 OD of groove
2.	0.014	6 7/16 (±0.010) centerline cam roller shaft to bottom of ID
3.	0.012	8.235/8.250 OD
4.	0.0065	11.932/11.912 groove diam
5.	0.0028	9.165/9.135 bore diam
6.	0.00636	4.4464 (+0.005 –0.002) spline bore diam
7.	0.00217	3.678/3.698 ID bore
8.	0.003	5.560/5.580 OD
Misc. Machines		
1. Drill Press	0.01559	0.302/322 centerline of tapped hole
2. Drill Press	0.0032	2.335/2.305 spot face dimension
3. Drill Press	0.001	0.635/0.625 diam bolt hole
4.	0.0027	5.135/5.115 bore diam
5.	0.0034	5.916/5.901 bore diam
6. Thd. Miller	0.006	11.829/11.817 pitch diam
7. Thd. Miller	0.0031	10.4545/10.4425 pitch diam

the center line is read as 3.69. In other words, if our machining equipment were just capable of meeting the 0.0026-inch tolerance on the bolt and nut, the control charts were maintaining the average size of each at the midpoint of their respective tolerance ranges, the assemblies would vary from 0.00075-inch loose to 0.00445-inch loose. A total of 0.0015-inch or about 35 per cent of the allowed assembly tolerance would never be used, for all practical purposes.

2. Since 0.0052-inch is allowed for the assembly, set the straightedge horizontal at this value on the central scale, and read 0.0037-inch from each side scale as the allowable natural tolerance for each component. The tolerance for each component of a ½-20, class-2 thread is 0.0036-inch. With a control chart one can get class-3 assemblies at class-2 prices.

Today the designer is often faced with a certain assembly fit or clearance tolerance requirement for proper functioning. He finds that the several tolerances applied to individual parts might accumulate so that, by the time he divides the assembly tolerance to allocate portions of it to each part, he sometimes wonders (and almost always the production department wonders) how any part can be made to such close limits. This inherent difficulty has contributed in a great measure to the rather unfair criticism levelled against designers in which they are accused of being anxious not to get into trouble, so in picking tolerances they think of the smallest number they know of and then they halve it.

That there is a practical solution to this difficulty can be illustrated as in *Fig.* 4, which shows a demonstration setup made to portray these statistical principles in action. Five parts to be assembled are represented by blocks of five different colors. There is a set of blocks of each color which vary in height in accordance with an approximately normal distribution. If the shortest blocks of each color are stacked against the vertical board, they reach a black horizontal line scribed thereon. The tallest ones add up to the other black line. Closer together than this pair of solid black lines is a pair of broken red lines which represent the "1.3 chances in 1000" extreme limits. After the short and long blocks are returned to their five piles, a random and repeated selection of one of each color should almost invariably result in a stack height that comes between the red lines. The region between these and the black ones, thus, is unused tolerance.

Values Determined With Nomogram

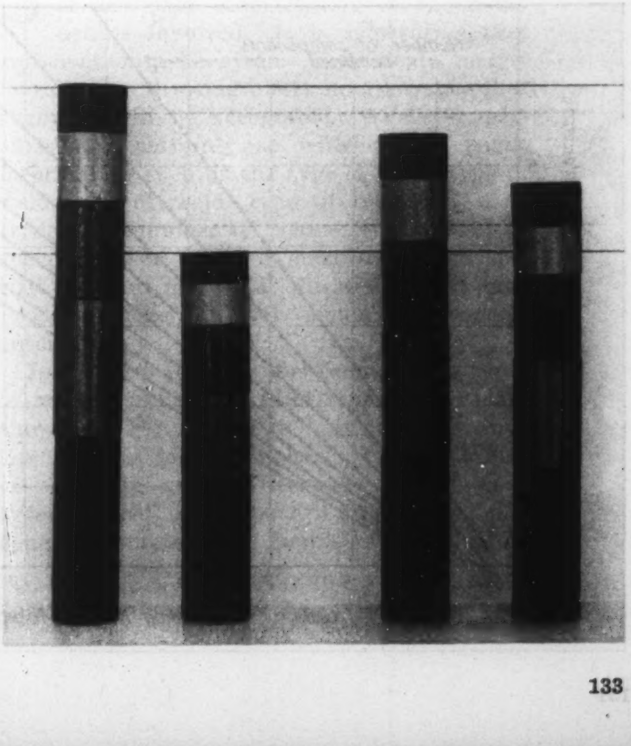
Designers can assign workable tolerances to components whose algebraic sum would far exceed the limits for a workable assembly. How they would add up statistically can be determined by entering *Fig.* 3 with a pair of values, then pairing up this resultant with the next tolerance, etc., each resultant sum always being read on the center scale. When either component tolerance exceeds 5 units, use the left side of each line instead of the right. When 20 units are exceeded, return to the right side of each line, calling 20, 2.0, etc.

Also gone should be the days when designers distribute the tolerance load among parts according to empirical rules concerned with the size of the dimension, internal or external dimensions, etc. In a statistically controlled shop, factual data are available which will permit engineering, production engineering or tooling, and the shop to work as a unit on these matters. The shop, from its existing control charts, furnishes a table of natural tolerances against the part number and dimension being fabricated, classified by equipment identification tag number. A partial listing from our shop equipment is shown in TABLE I. Please note that the specification or drawing tolerances listed were established by conventional means rather than by the statistical method recommended herein. Also many of these tolerances had been increased to the listed amounts by production department pressure because, without their new control-chart tool, the limits could not be met. In many cases, it will be observed, the comparison with what is now actually needed is startling.

Shewhart Chart Provides Natural Tolerances

Thus, to aid him in distributing the tolerance load for a new design, the designer has such a tabulation and a schedule from production engineering showing the expected idle time on particular machines. The nomogram of *Fig.* 3 should then make possible many an otherwise "impossible" job. If, even with the very substantial extra tolerance thus available by this method of statistical addition, the required end tolerance cannot be achieved, the item or items of new equipment needed are known. What they must be able to hold to is also known. The Shewhart control chart needs only thirty successive pieces from the equipment to obtain a very reasonable estimate of

Fig. 4—A demonstration setup for showing how tolerances accumulate statistically as against those accumulated algebraically by conventional methods



its natural tolerance. In some cases arrangements might be made for such a test run to prove the adequacy of the equipment even before it is purchased.

All this, and the virtual elimination of scrap, rework, arguments, and tolerance increasing engineering changes before a new design really rolls in production sound like the jingle of money in the company's pockets.

Another chart, *Fig.* 5, completes the aid to designer in saving involved computations. This serves for the special case where more than two components are involved and the component tolerances are all equal—or close enough to being so to make that assumption justified for purposes of a first approximation. Here, starting with the known component tolerance, the assembly tolerance can be determined with one reading instead of re-entering the nomogram. Starting with a known assembly tolerance, the component tolerance can be immediately found, while the nomogram would require a trial-and-error procedure.

Special Marking Desirable

There are two reasons why each tolerance determined by this recommended statistical method should be so indicated by some special marking on the drawing. First, the method is *only* valid when a control chart keeps the distribution free from other than just momentary assignable causes of variation. Consequently, in a transition period of conversion to this method, this drawing indication would be a constant reminder to everyone that the job must *not* run without a Shewhart chart. Second, it is only logical that in a plant becoming familiar with the advantages taken of the probabilities of mating extremes, certain out-of-tolerance material can be accepted by special deviation when the computed chance (of obtaining an assembly beyond the straight algebraic summation fit limits) is too small to consider it as significant. The special drawing mark will indicate that all possible allowance has been made and that one should not deviate on parts byond these limits using the statistical method on the assumption that it was not employed in setting up the tolerances.

Suggested Standard Notation

It is only natural for any individual concern to be reluctant to adopt a new method involving special drawing notations when these drawings have to be used by suppliers and even customers, unless the notation be recognized as a standard procedure, and unless the procedure be understood by these parties. As a suggestion, the standard notation could well be, for example, 0.4662 (0.0018). This case would be read as "0.4662 plus or minus 0.0018-inch, maximum variation of individual sizes as controlled by a Shewhart chart." The first figure gives the desired average value, and that included in the parentheses denotes use of the statistical method.

These recommendations are a recognition of the fact that control of the actual dimensional averages and variations therefrom are not dictated by drawings nearly as much as they are, in the order named, by five other factors: (1) Shop gages, (2) shop operators, (3) fabricating equipment, (4) inspection gages, and (5) inspectors. The drawings are only the first approximation of what three of those factors—shop gages, manufacturing equipment and inspection gages—should be. In some shops this situation is realized by the drawings not being used at all, once the "tooling" is selected. Vendors often realize this by making parts to the purchaser's inspection gages and not to his drawings. These Shewhart control charts measure the "tooling" average and variations and in addition are the only control and recognition of the remaining two factors—the part the operator and inspector as humans play in the establishment of the actual sizes obtained.

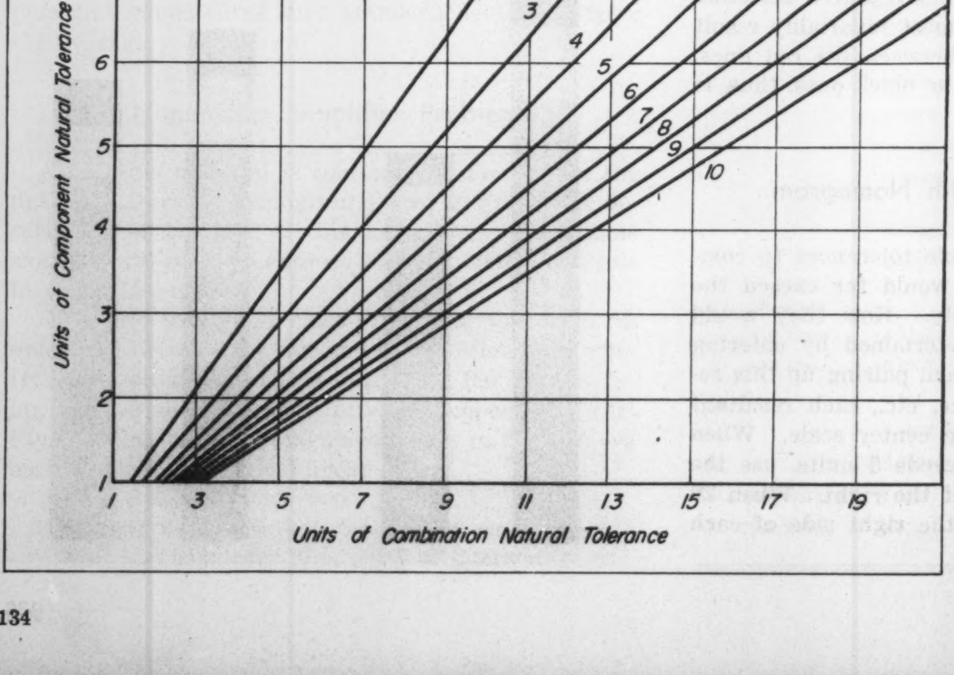
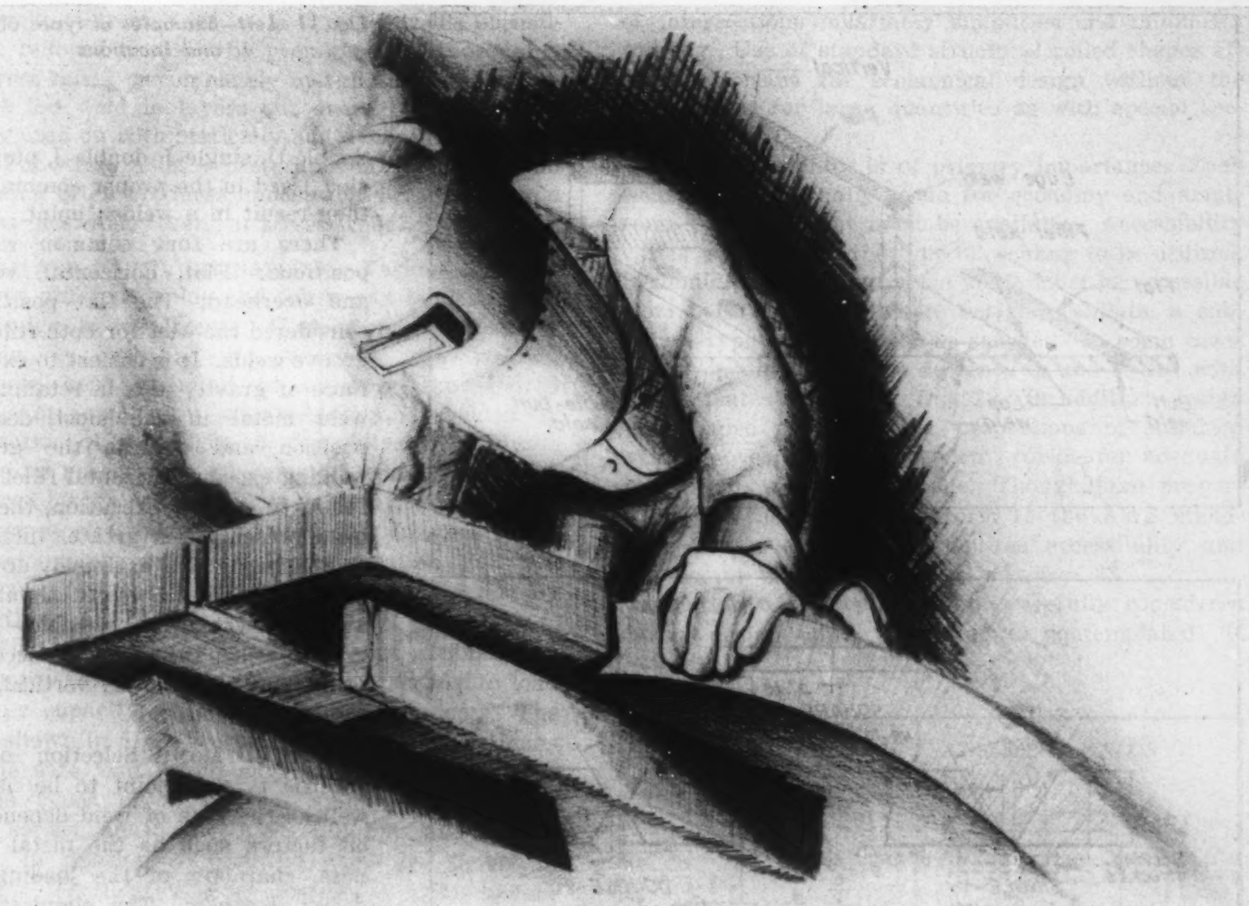


Fig. 5—Chart for determining combined tolerances where two or more components are involved and all have equal tolerances



PRODUCTION PROCESSES...

Their Influence On Design

By Roger W. Bolz
Associate Editor, Machine Design

Part XLIV–Welding, Design Factors

SUCCESS in welded design is the result of adequate consideration of the many details involved. It is imperative that sufficient data be given. To indicate merely "weld" on a drawing offers no assurance that the unit will be acceptable. Wherever possible, and certainly so with critical parts, information such as the type of joint, type of weld, size of weld, type of electrode, electrode size, number of passes, etc., should be specified. The designer must select and specify the joint and weld; the welder may only produce correctly that which is properly specified.

JOINTS AND WELDS: The fundamental types of welded joints and weld nomenclature are shown in *Fig.* 11. The butt, corner, edge, lap, and tee joints are basic, but variations of each are used. There are twelve basic types of weld: Fillet, square groove, single-V, double-V, single bevel, double bevel, single-U,

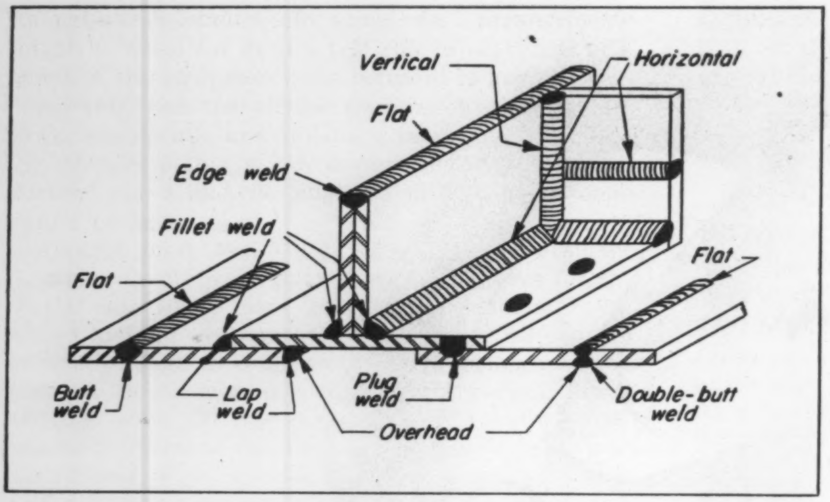

Vertical
Horizontal
Flat
Edge weld
Fillet weld
Flat
Flat
Butt weld
Lap weld
Plug weld
Overhead
Double-butt weld

Fig. 11—Left—Examples of types of welds and locations

double-U, single-J, double-J, plug, and slot. Used in the proper combinations they result in a welded point.

There are four common welding positions: Flat, horizontal, vertical and overhead. The flat position is considered the best for both fillet and groove welds. It is easiest to execute; force of gravity aids in retaining the weld metal in the most desirable position and permits the greatest welding speed. Horizontal fillet welds follow in ease of execution, the overhead presents still greater difficulty, and the vertical is extremely difficult. Overhead fillet welds should be avoided whenever possible. With groove welds the sequence according to difficulty would be; vertical, horizontal and overhead.

JOINT DESIGN: Selection of the specific type of joint to be used as well as the type of weld depends upon factors such as the metal thickness, character of the loading, and design features. The simplest joint is the square butt which requires the least amount of preparation. The square butt joint, however, is only suitable for relatively thin material; to secure adequate welds on heavier plate, specially prepared joints are utilized, the particular design depending upon the application. The various joint designs are shown in *Fig.* 12 along with data relative to suitable metal thickness.

Where members used require supplementary strength over that offered by edge welds, the plug weld is often advantageous. Dimensional requirements for plug welds as suggested by Priest* are shown in *Fig.* 13. Plug welds in plate up to ⅝-inch should be filled in flush with the plate. Ordinarily, plug welds in plate over ¾-inch are not economical.

Open roots are used to insure complete penetration in square, bevel, and V-butt welds. Joints of the J and U types are usually assembled with a closed root to afford better control of warpage and shrinkage.

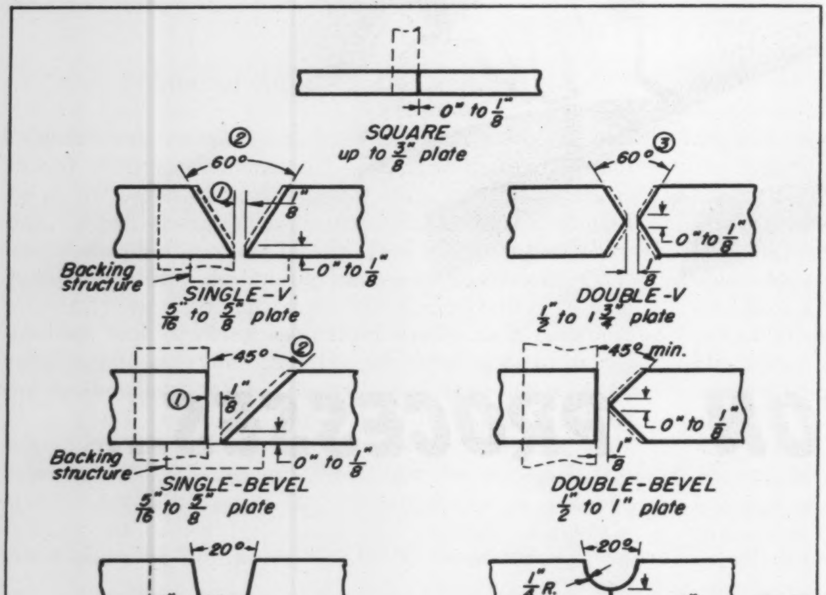

0" to 1/8"
SQUARE
up to 3/8" plate
②
60°
①
1/8"
0" to 1/8"
Backing structure
SINGLE-V
5/16" to 5/8" plate
60° ③
0" to 1/8"
1/8"
DOUBLE-V
1/2" to 1 3/4" plate
45° ②
①
1/8"
0" to 1/8"
Backing structure
SINGLE-BEVEL
5/16" to 5/8" plate
45° min.
0" to 1/8"
1/8"
DOUBLE-BEVEL
1/2" to 1" plate
20°
1/4" R.
1/8"
SINGLE-U
1/2" to 3" plate
20°
1/4" R.
1/8"
DOUBLE-U
2" plate and up
20°
1/8"
1/2" R.
SINGLE-J
1/2" to 3" plate
20°
1/8"
1/2" R.
DOUBLE-J
1 1/2" plate and up
Easy transition into base metal and no undercutting nor overlapping at toes.
Practical minimum; 1/8" maximum
Minus tolerance = 0
All forms of grooves, single or double
Reinforcement
① 1/8" min., with backing structure
② May be less with backing structure and wider root opening
③ May be less with wider root opening

Fig. 12—Left—Typical joint proportions as suggested by AWS and applicable metal thickness. Typical suggested weld reinforcement for welds is also shown

The greater stresses set up in U and J welds normally are relieved partially by peening, more thoroughly by stress relief, or completely by full annealing. Peening of the weld in layers not over $\frac{1}{8}$-inch thick is widely used on both statically and dynamically loaded parts but stress relief is preferable on the latter. Full annealing often produces undesirable heavy scale and is less desirable than a stress relief.

WELD AND JOINT COMBINATIONS: Various combinations of different welds and joints can be utilized in the design of weldments. Cost of preparation for welding as well as the cost of the welding must be kept in mind in selecting the desired weld. For instance, a square-butt joint welded by penetration of the edges of the plates only, allows a welding speed some 80 per cent greater than one produced by the use of filler metal and also eliminates the cost of electrode or rod material. In some cases, however, joints produced by penetration will not withstand fatigue loads as well as joints made by deposition.

In *Fig.* 14, a variety of weld and joint combinations are shown along with pertinent data relating to load carrying capacity, efficiency and relative costs. The chart shown in *Fig.* 15 provides a means for estimating the safe load which may be expected from the various types of arc welds. Standard fillet weld sizes, as set up in the AWS Building and Bridge Codes, in relation to material gage are shown in *Fig.* 16. These weld sizes provide a joint having sufficient strength so as not to crack on shrinking. The minimum length of any fillet weld for strength purposes should not be less than four times its size; that for butt welds is commonly set at four times the throat.

JOINT FIT-UP: In the selection and specification of joint design it is well to consider the problem of joint fit-up. Easy fit-up without excessive labor or welding should be the primary aim. Variations in the methods used in preparing joints should be kept in mind to provide the greatest leeway in assembly. The effect of poor fit-up on welding speed is great; welding speed is reduced 65 per cent when welding $\frac{1}{8}$-inch material with $\frac{1}{8}$-inch gap and 75 per cent with a $\frac{1}{4}$-inch gap on $\frac{1}{2}$-inch plate, *Fig.* 17. A few suggestions regarding desirable and undersirable joint arrangements are shown in *Fig.* 18.

In using castings or forgings for parts of weldments, parting lines should be located so as to reduce any preliminary fitting up. With forgings, the sheared faces produced in trimming can be used to provide the matched edges. It is preferable to have the joint in edges of equal thickness to assure the most satisfactory weld, *Fig.* 19. To simplify joints and minimize weld requirements, large massive welds should be avoided, *Fig.* 20.

GENERAL DESIGN: Use of special shapes, such as in *Fig.* 20, assures a joint with predictable strength and capable of accurate inspection. Furthermore, heavy welds will usually lead to excessive warping in many cases. Use of a simple central member for all types of intersections invariably simplifies and minimizes welding. Use of standard structural rolled shapes affords a means for economical design without the requirement for large quantities as with special sections, *Fig.* 21.

Joint accessibility is of primary importance. Each weld must be readily made for economy and ample room for equipment must be available. Accessibility varies according to the type of welding to be utilized. It should be noted that some joints must be accessible from both sides and where design prohibits, a substitute type of weld must be selected. In some cases access openings must be designed-in and sealed with covers plates afterward, *Fig.* 22. In addition, design should also recognize the proportions of standard weld grooves and fit-up which provide for adequate accessibility for the electrode. Though joint proportions need not exactly conform to the AWS standards, proper penetration requires accessibility and this factor should be recognized, *Fig.* 23.

Location of joints should be carefully considered during design when machining is contemplated. It is both uneconomical and often unwise to locate a joint so that part of the weld must be removed in machining. Some suggested alternatives to machining a weld are shown in *Fig.* 24. Machining after welding, in any case, should be reduced to a bare minimum.

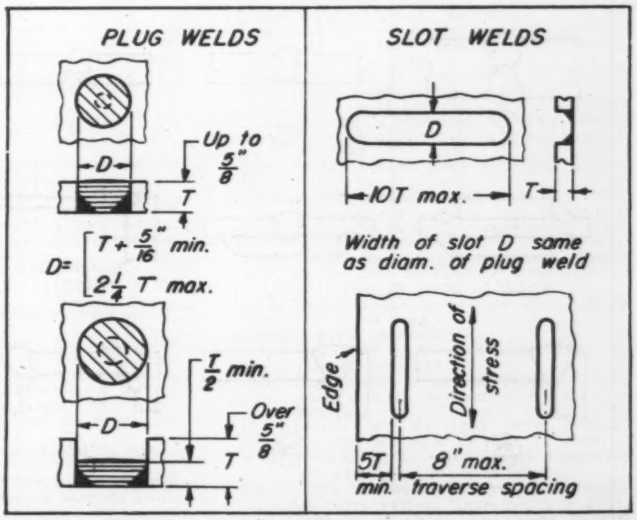


Fig. 13—Proportions of plug welds. These may be stressed in shear at the working stresses allowed for fillet welds

Joint design should be such that stresses will be well balanced to distribute the load uniformly across the weld. Some unbalanced designs and possible improvements are indicated in *Fig.* 25. Wherever possible the welding should be uniformly distributed about the neutral axis of the structure and also of each joint. This decreases distortion produced and also allows the use of lighter fixtures. Fit-up cost, however, may be increased where balanced design is used. It may be economical, though, if stress relief is not possible or not imperative because of no subsequent machining or similar reasons, and

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* *Practical Design of Welded Steel Structures*—H. Malcolm Priest, American Welding Society, New York, 1943.

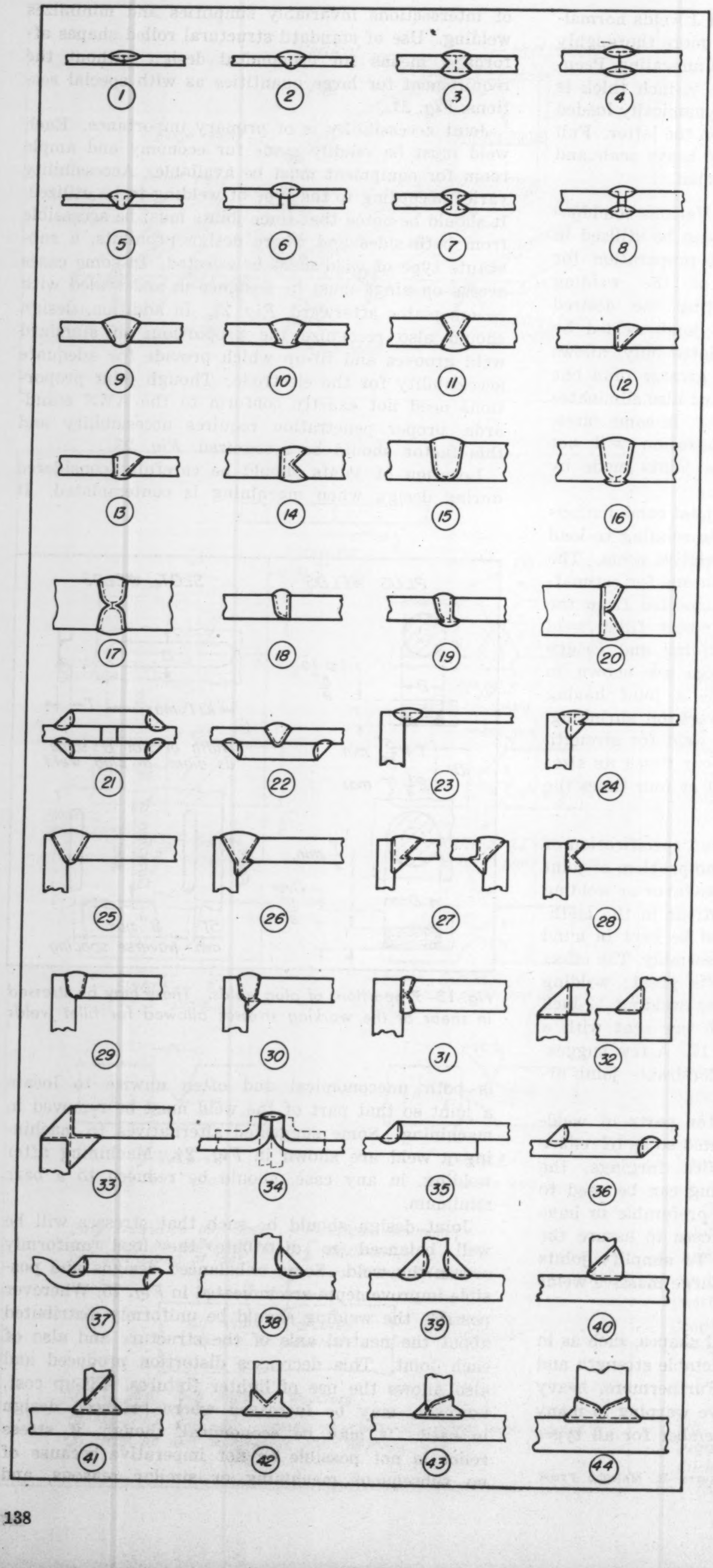


Fig. 14—A variety of typical welded joint combinations and efficiency characteristics as recommended by AWS

1. Square-Butt Joint. Welded one side, incomplete penetration.
- (a) Simplest form of joint
- (b) Efficiency low
- (c) Not suitable for fatigue or impact
- (d) Should not be used when bending tension can come on root of weld.

2. Square-Butt Joint. Welded one side.
- (a) Complete penetration can be obtained on very thin materials, ⅛-in. max
- (b) Efficiency in static tension is dependent on degree of penetration
- (c) If complete, fairly high efficiency obtainable
- (d) Not advisable to use in severe fatigue and impact or with bending tension on root.

3. Square-Butt Joint. Welded both sides.
- (a) Complete penetration can be obtained on thin materials, about 3/16-in. maximum. Possibility of obtaining complete penetration should be checked before using on important structures
- (b) High efficiencies obtainable
- (c) Should not be used for fatigue or impact unless in very thin material where complete penetration can be assured.

4. Square-Butt Joint. Welded both sides, incomplete penetration.
- (a) Relatively low efficiency in static loading
- (b) Should not be used in fatigue or impact.

5. Open, Square-Butt Joint. Welded one side.
- (a) Complete penetration possible in relatively thin materials, 3/16-in. max
- (b) Relatively high efficiencies obtainable in thin material
- (c) Should not be used in severe fatigue or impact
- (d) Should not be used when bending tension can occur in root of weld.

6. Open, Square-Butt Joint. Welded one side, incomplete penetration.
- (a) Greater penetration possible than in case of Joint 1
- (b) Low efficiency in static loading
- (c) Should not be used in fatigue or impact
- (d) Should not be used when bending tension can come in root of weld.

7. Open, Square-Butt Joint. Welded both sides.
- (a) Complete penetration can be obtained in moderately thin plate, ¼-in. max
- (b) Relatively high efficiencies can be obtained if complete penetration is assured
- (c) Should not be used for severe fatigue and impact because of likelihood of flaws at root of weld.

8. Open, Square-Butt Joint. Welded both sides, incomplete penetration.
- (a) Relatively low efficiency in static loading dependent on ratio of weld throat to plate thickness
- (b) Should not be used in fatigue or impact.

9. Single-V Butt Joint. Welded one side.
- (a) Relatively high static efficiency obtainable
- (b) Should not be used when bending tension can exist at root of weld
- (c) Undesirable in fatigue or impact
- (d) Economical in moderate thicknesses of plating, about 5/8-in. maximum
- (e) Better efficiency and production in arc welding can be obtained when backing structure is used.

10. Single-V, Butt Joint. Welded both sides.
- (a) High static efficiencies obtainable
- (b) Economical in moderate thicknesses, about 5/8-in. maximum
- (c) If root is chipped or good root penetration otherwise secured, good efficiency can be obtained in fatigue or impact; better if reinforcements are removed.

11. Double-V, Butt Joint.
- (a) High static efficiencies obtainable
- (b) Economical in intermediate thicknesses of plating, about 1¾ in. maximum
- (c) Chipping of root difficult
- (d) If root is chipped or good root penetration otherwise secured, good effeciency can be obtained in fatigue or impact; better if reinforcements are removed.

12. Single-Bevel, Butt Joint. Welded one side.
- (a) Relatively high static efficiencies obtainable
- (b) One member only need be beveled
- (c) Should not be used when bending tension can exist at root of weld
- (d) Undesirable in fatigue or impact
- (e) Economical in moderate thicknesses of plating, about 5/8-in. maximum
- (f) Better efficiency and production in arc welding can be obtained when backing structure is used.

13. Single-Bevel, Butt Joint. Welded both sides.
(a) High static efficiencies obtainable
(b) Economical in moderate thicknesses, about 5/8-in. maximum
(c) One member only need be beveled
(d) If root is chipped or good root penetration otherwise secured, good efficiency can be obtained in fatigue or impact; better if reinforcements are removed.

14. Double-Bevel, Butt Joint.
(a) High static efficiencies obtainable
(b) Economical in intermediate thicknesses of plate, about 1 in. maximum
(c) Chipping of root very difficult
(d) One member only need be beveled
(e) If root is chipped or good root penetration otherwise secured, good efficiency can be obtained in fatigue or impact; better if reinforcements are removed.

15. Single-U, Butt Joint. Welded one side.
(a) High efficnency obtainable
(b) Economical from moderate thicknesses, about ½-in. upward
(c) Undesirable in severe fatigue or impact
(d) Undesirable when bending tension can come on root of weld.

16. Single-U, Butt Joint. Welded both sides.
(a) Highest static efficiencies obtainable
(b) Economical from moderate thicknesses, about ½-in. upward
(c) Chipping of root easy
(d) Root faces facilitate assembly and prevent closing of joint during welding
(e) If root is chipped or good penetration otherwise secured, high efficiencies can be obtained in fatigue and impact; higher if reinforcements are removed.

17. Double-U, Butt Joint.
(a) Highest static efficiencies obtainable
(b) Most economical in the heaviest gages
(c) May be symmetrical about center line or asymmetrical as desired
(d) Chipping of root relatively easy
(e) Root faces facilitate assembly and prevent closing of joint during welding
(f) If root is chipped or good penetration otherwise secured, high efficiencies can be obtained in fatigue and impact; higher if reinforcements are removed.

18. Single-J, Butt Joint. Welded one side.
(a) High static efficiency obtainable
(b) Economical from moderate thicknesses, about ½-in. upward
(c) Undesirable in severe fatigue or impact
(d) Undesirable when bending tension can come on root of weld
(e) One member only need be grooved
(f) Root face facilitates assembly and prevents closing of joint during weld.

19. Single-J, Butt Joint. Welded both sides.
(a) Highest static efficiencies obtainable
(b) Economical from moderate thicknesses, about ½-in. upward
(c) Chipping of root easy
(d) Root faces facilitate assembly and prevent closing of joint during welding
(e) One member only need be grooved
(f) If root is chipped or good penetration otherwise secured, high efficiencies can be obtained in fatigue and impact; high if reinforcements are removed.

20. Double-J, Butt Joint.
(a) Highest static efficiencies obtainable
(b) Most economical in the heaviest gages
(d) Chipping of root not as easy as Joint 17, and there is likelihood that joint may not be as good as Joint 17
(c) May be symmetrical about center line or asymmetrical as desired
(e) One member only need be grooved
(f) If root is chipped or good penetration otherwise secured, high efficiencies can be obtained in fatigue and impact; higher if reinforcements are removed.

21. Open, Double-Strapped, Butt Joint.
(a) Joint capable of developing high static efficiency depending on size of welds
(b) Excess weight of straps undesirable
(c) Fillet welds cause concentrations of stress that in fatigue and impact would be undesirable
(d) Not as economical as a butt joint.

22. Single-Strapped Single-V, Butt Joint.
(a) Joint capable of developing high static efficiency
(b) Excess weight of strap undesirable
(c) Fillet welds cause concentrations of stress that in fatigue and impact would be undesirable
(d) Eccentricity of strap causes joint to bend under load
(e) Butt joint alone capable of carrying load and fillet welds cause excess cost.

23. Open, Square-Groove, Corner Joint.
(a) Complete penetration possible in relatively thin materials, 3/16-in. max
(b) Relatively high efficiencies obtainable in shear
(c) Should not be used in fatigue or impact
(d) Should not be used when bending tension can occur in root of weld. Direct tension on either member can cause bending tension at root.

24. Open, Square-Groove, Corner Joint. Fillet-welded.
(a) High efficiencies obtainable in static loading
(b) Not particularly desirable in severe fatigue or impact
(c) Complete penetration possible in relatively thin materials, ¼-in. max.

25. Single-V, Corner joint.
(a) Relatively high efficiencies obtainable in shear
(b) Should not be used in fatigue or impact
(c) Should not be used when bending tension can occur in root of weld. Direct tension on either member can cause bending tension at root
(d) Economical in moderate thicknesses, about 5/8-in. maximum.

26. Single-V, Corner Joint. Fillet welded.
(a) High efficiences obtainable
(b) Not particularly desirable in severe fatigue or impact, due to concentration of stress at toes of fillets
(c) Economical in moderate thicknesses, about 5/8-in. maximum.

27. Outside, Single-Bevel Corner Joint. Fillet welded.
(a) High efficiencies obtainable
(b) Not particularly desirable in severe fatigue or impact, due to concentration of stress at toes of fillets
(c) One member only need be beveled
(d) Economical in moderate thicknesses, about 5/8-in. maximum.

28. Double-Bevel, Corner Joint.
(a) High efficiency obtainable in static shear
(b) Economical in intermediate thicknesses of plate, about 1 in. maximum
(c) Chipping of root very difficult
(d) One member only need be beveled
(e) Neither member should be subjected to severe tension because of concentrations of stress at corner
(f) Not advisable in severe impact or fatigue.

29. Single-U, Corner Joint.
(a) High efficiencies in static shear obtainable
(b) Economical from moderate thicknesses, about ½-in. upward
(c) Undesirable in fatigue or impact
(d) Undesirable when bending tension can come on root of weld. Direct tension on either member can cause bending tension on root.

30. Single-U, Corner Joint. Fillet-welded.
(a) Highest efficiencies in static shear obtainable
(b) Economical from moderate thicknesses, about ½-in. upward
(c) Chipping of root easy and accessible
(d) Root faces facilitates assembly and prevent closing of joint during welding
(e) Not particularly desirable in severe fatigue and impact due to concentrations of stress at toes of fillet.

31. Double-J, Corner Joint.
(a) High efficiences obtainable in static shear
(b) Most economical in the heaviest gages
(c) Chipping of root not as easy as Joint 30, and there is likelihood that joint may not be as good as Joint 30
(d) One member only need be grooved
(e) Neither member should be subjected to severe tension because of concentrations of stress at corner
(f) Not advisable in severe impact or fatigue
(g) Root face facilitates assembly and prevents closing of joint during weld.

32. Outside—(And Inside) Single-Fillet-Welded, Corner Joint.
(a) Capable of developing high efficiencies in static bending with bending tension on the face
(b) Will fail at low values if root of weld is subjected to tension. Direct tension on either member will subject the root of the weld to tension
(c) High efficiencies obtainable in static shear.
(d) Not economical when fillets are of large size
(e) Should not be used in impact and fatigue.

33. Double-Fillet-Welded, Corner Joint.
(a) High efficiencies obtainable in static shear
(b) Can develop good efficiency in static bending
(c) Uneconomical in greater than moderate thicknesses of plate
(d) Not particularly desirable in severe impact and fatigue because of concentrations of stress at toes of fillet.

34. Square-Edge Joint.
(a) Should not be used when either member is subjected to direct tension
(b) Should not be used when joint is subjected to bending so that bending tension exists at root of weld
(c) Capable of developing high efficiencies in shear
(d) Limited penetration only can be obtained
(e) Should not be used in impact or fatigue
(f) Economical joint for unimportant joints in multiple production.

35. Single-Fillet Welded, Lap Joint.
(a) Should not be used when root of weld can be subjected to bending. Will distort out of line under tension, subjecting root to bending tension
(b) Capable of developing high efficiencies in shear
(c) Should not be used in impact or fatigue
(d) Economical in moderate thickness.

36. Double-Fillet-Welded, Lap Joint.
(a) Can develop high efficiency in tension when lap is five times the thickness or more
(b) Undesirable in fatigue or impact, due to concentrations of stress at toes of fillets
(c) Will distort out of line functioning as an expansion joint (rotate under tension)
(d) Capable of developing high efficiencies in shear
(e) Easy to fit
(f) Economical in moderate thicknesses.

37. Double-Fillet-Wleded, Joggled, Lap Joint.
(a) Capable of developing high efficiencies in shear
(b) Under static tension will distort greatly and will fail in joggle at some efficiency less than 100 per cent
(c) Functions as expansion joint (compression and tension)
(d) Easy to fit
(e) Undesirable in fatigue or impact due to concentrations of stress at toes of fillets
(f) Useful for obtaining flush surface on one side of plating.

33. Single-Fillet-Welded, T-Joint.
(a) Capable of developing high efficiencies in static bending with bending tension on face
(b) Will fail at low values if root of weld is subjected to tension
(c) Will fail at low value if perpendicular member is subjected to direct tension
(d) Capable of developing high strength in shear
(e) Should not be used in fatigue or impact.

39. Double-Fillet-Welded, T-Joint.
(a) Capable of developing high efficiencies in static tension, compression, shear and bending
(b) Inadvisable to use in severe fatigue or impact, because of concentrations of stress at roots of fillets
(c) Uneconomical in greater than moderate thicknesses.

40. Single-Bevel, T-Joint.
(a) Relatively high static efficiencies obtainable in shear
(b) Undesirable to use in fatigue or impact due to concentrations at corners
(c) Should not be used when bending tension can occur in root of weld
(d) Economical in intermediate thicknesses, about 5/8-in. maximum
(e) One member only need be beveled.

41. Double-Fillet-Welded, Single-Bevel, T-Joint.
(a) Highest efficiency can be developed in static tension, compression, shear and bending
(b) Economical in intermediate thicknesses, about 5/8-in. maximum
(c) One member only need be beveled
(d) Root accessible for chipping
(e) Moderately good efficiency in fatigue and impact can be obtained.

42. Double-Fillet-Welded, Double-Bevel, T-Joint.
(a) Highest efficiency can be developed in static tension, shear, compression and bending
(b) Economical in moderate thicknesses, about 1 in. maximum
(c) One member only need be beveled
(d) Chipping of root somewhat more difficult than Joint 41
(e) Moderately good efficiency in fatigue and impact can be obtained.

43. Double-Fillet-Welded, Single-J, T-Joint.
(a) Highest efficiency can be developed in static tension, compression, bending and shear
(b) Economical in intermediate to heavy thicknesses
(c) Root accessible for easy chipping
(d) Root face facilitates assembly and prevents closing of joint during weld.
(e) Moderately good efficiency in fatigue and impact can be obtained.

44. Double-Fillet-Welded, Double-J, T-Joint
(a) Highest efficiency obtainable in static tension, compression, bending and shear
(b) Economical in the heaviest thicknesses
(c) Chipping of root not as easy as Joint 43
(d) Root face facilitates assembly and prevents closing of joint during welding
(e) Moderately good efficiency in fatigue and impact can be obtained.

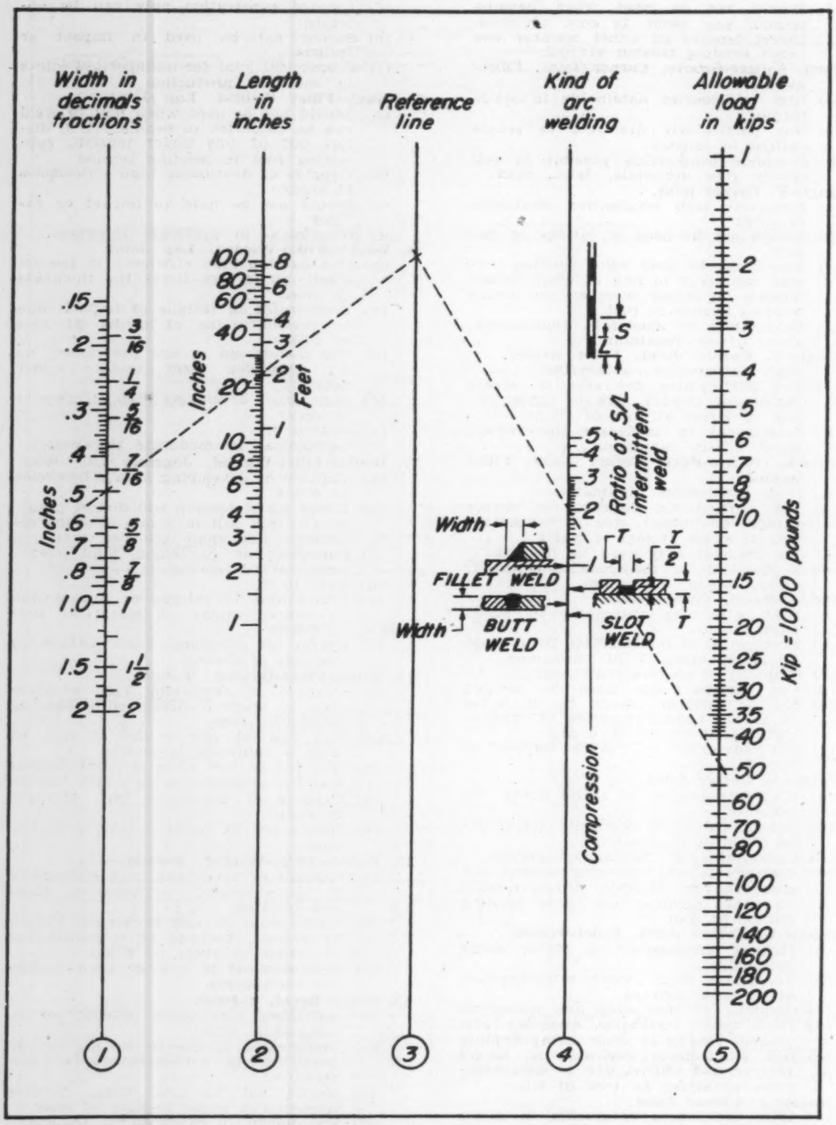


Fig. 15—Chart for estimating safe loads on welded joints constructed on a basis of 13,000 psi for tension, 15,000 psi for compression and 11,300 psi for shear, all loads acting through the center of gravity of a section

freedom from warpage as well as precision is desired. In some cases, better load-carrying ability can be obtained by utilizing more expensive preliminary fit-up. As shown in *Fig.* 26, the possibility of using less expensive fillet welds without complete penetration can result from proper consideration of fit-up accuracy. It is highly important to avoid abrupt changes in metal sections or abrupt changes in stiffness of a structure, *Fig.* 27. The design solution for such cases is shown in *Fig.* 28.

MATERIALS: In most designs the tensile strength of a material is usually the primary criterion in selection. The various other properties, however, must be considered before specifying in order to assure maximum economy and efficiency. Such qualities as weight, corrosion resistance, workability, forms available, cost, etc., may often exert considerable effect. In welding, the weldability of metals is important. Most metals can be welded but, as a rule, require different techniques.

Weldability of Metals

Weldability of materials depends mainly upon the presence of elements which react to produce hardening or embrittlement. With steels, carbon is the critical element. Carbon content of steels should be limited to a maximum of 0.25 to 0.30 per cent to assure ready weldability and minimum distortion. Low-carbon steels such as open-hearth require little preparation and minimum skill in welding and should be used

Fig. 16—Below—Chart of fillet weld sizes as specified in AWS Building and Bridge Codes. The minimum size fillet weld for strength purposes should be limited to 3/16-inch

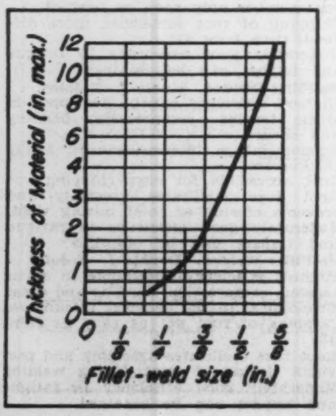
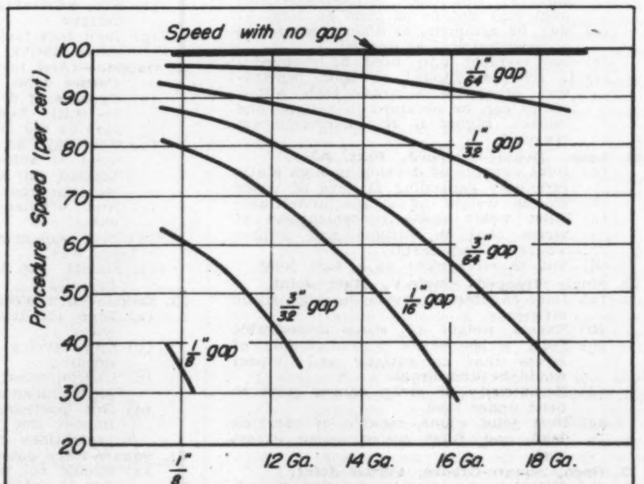


Fig. 17 — Right — Chart showing general effect of joint fit-up on welding speed with flat butt welds in sheet steel



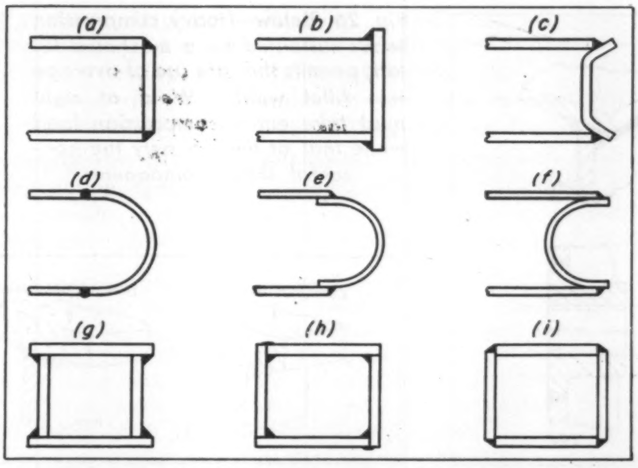
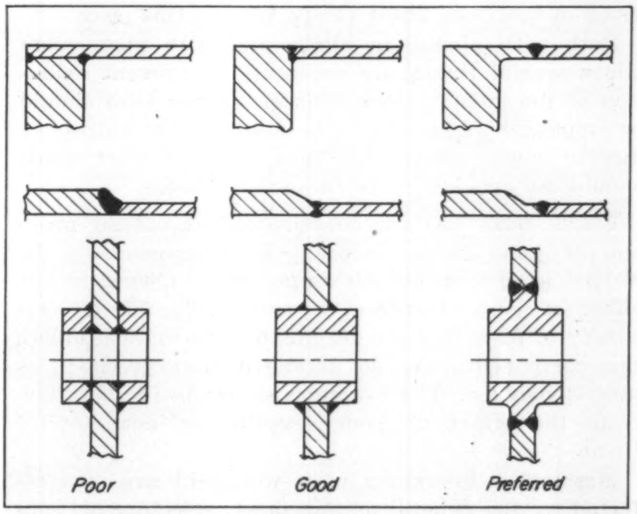


Fig. 18—Above—Economical joint designs which eliminate precision fit-up. Joint (a) requires close limits on diameter and end squareness, at (b) the design is better and more suited to automatic welding while (c), a pressing, produces excellent fit-up at very low cost. Similar conditions are present at (d), (e) and (f). Design at (c) and (f) is not desirable where high stresses are encountered. Parallel plates at (i) produce the best fit-up at lowest cost

Fig. 19—Below—The lightest gage plate should always be welded and if possible the thicknesses should be equal



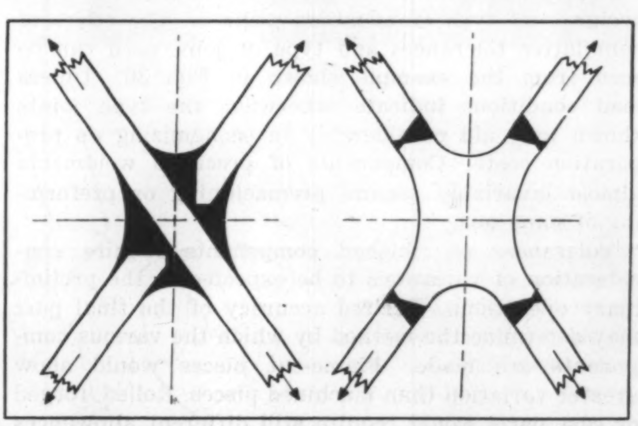


Fig. 20—Above—Large, massive welds require an excessive amount of weld metal and do not have the predictability of a joint designed around a special shape

Fig. 21—Below—Woldridge grader blade base utilizes a split H-beam and plate

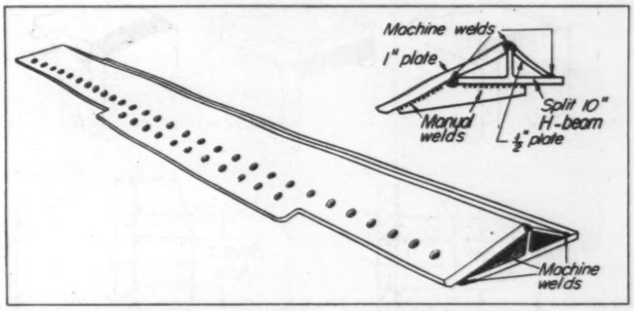
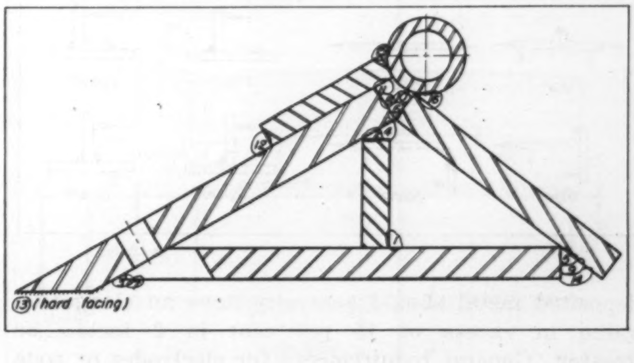


Fig. 22—Above—Adequate accessibility for performing the necessary welding operations is apparent on this production diesel engine frame

Fig. 23—Below—Welding sequence for a part on which joint accessibility is inadequate at beads 2, 5, 11 and 16



wherever it is possible to do so. Where higher carbon or alloy steels are required, they should be used only where necessary, *Fig.* 29.

Ductility in materials is important to permit distortion to take place without failure or permanent injury. Brittle materials or materials which produce brittle weld zones create internal stresses which rise to rupture values rapidly with only small distortions. Care must be exercised with such materials to eliminate as much as possible all undesirable residual stresses.

Ductility in the weld metal is also important, and

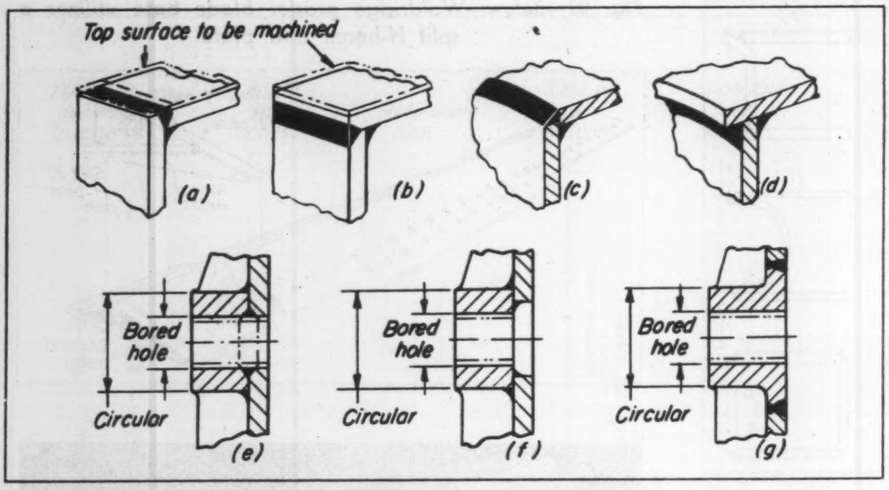


Fig. 24—Above—Joint at (b) requires only the amount of weld left after machining as at (a). Joint at (c) eliminates the kerf and its cost while (d) simplifies fitting. Design at (f) similarly saves weld metal over that at (e) but joint at (g) provides best results where stresses are encountered

Fig. 25 — Below — Some unbalanced joints under various loadings and suggested improvements

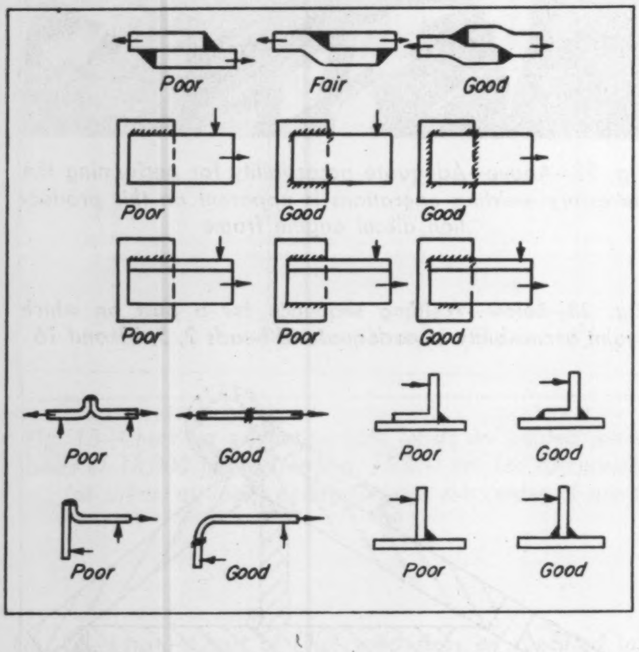
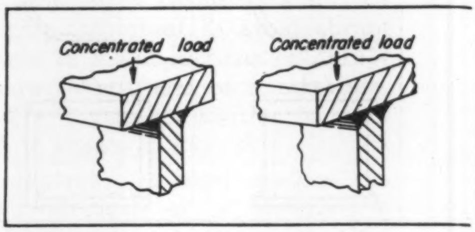


Fig. 26—Below—Heavy compression loads sustained by a machined fit, left, permits the safe use of average size fillet welds.. Weld at right must take entire compression load while that at the left only the horizontal shear components



deposited metal should generally have an elongation value in excess of 15 per cent in 2 inches or greater. General requirements for electrodes or rods vary considerably with the anticipated service. For strength alone, plain carbon steel electrodes are generally satisfactory for average low-carbon weldments. However, the electrode specified should if possible deposit weld metal of the same general composition as the parent metal or weld metal with similar physical characteristics.

Expansion coefficient of the materials to be welded should be considered. A considerable problem is encountered in the control of expansion and contraction with alloys such as austenitic chromium-nickel stainless. Cost of jigs, fixtures and special procedure may be excessive. Design of assemblies should be made in such a way as to obviate as much as possible the effects of expansion during welding.

A tremendous variety of rods for gas welding and electrodes for the various types of arc welding are available to suit almost any particular condition. Owing to the complexity involved, only the most commonly used forms of welding electrodes have been standardized. The classification and other pertinent data relative to usage, base materials, type of weld, etc., for the standard low-carbon and alloy electrodes are given in the Data Sheet (Page 151) in this issue.

Both with aluminum alloys and with magnesium alloys special fluxes are necessary to prevent oxidation of the metals. As a consequence no joint should be employed which offers the possibility of entrapped flux to cause corrosion. Thus, lap and fillet welds should be avoided in favor of butt welds.

TOLERANCES: As can be recognized from the problem of joint fit-up, accuracy of components to be welded is of considerable importance. Owing to the effect of joint clearance on speed, *Fig.* 17, the accuracy of fit with some designs may be critical unless the components are so arranged that precision is largely avoided. The examples shown in *Fig.* 18 illustrate the effect of joint selection on accuracy of fit-up.

Assembled tolerances of a weldment are also affected by the general arrangement, selection of joint design, and type of members utilized. The effect of cumulative tolerances and type of joint used can be seen from the example shown in *Fig.* 30. Unless load conditions indicate otherwise, the type joints shown may aid considerably in economizing on preparation costs. Components of precision weldments almost invariably require premachining or preforming of some sort.

Tolerances of finished components require consideration of variations to be expected in the preliminary operations. Desired accuracy of the final part may determine the method by which the various components are made. Flame-cut pieces would show greater variation than machined pieces. Rolled, forged or cast parts would require still different allowances depending upon their application. An example of possible accumulation of natural tolerances is shown in *Fig.* 31. The machine, the service, the subsequent finishing requirements, the importance of cost, shrinkage and similar points would be deciding factors in setting final weldment tolerances.

Due to the great number of variables encountered it is difficult to project definite figures for determining the effects of shrinkage. However, the AWS Handbook specifies a general rule for shrinkage in unpeened butt and fillet welds in medium-carbon steels:

Average transverse shrinkage per joint:

0.025-inch for two light (legs equal to one-half the gage of lighter member) continuous fillet welds, or one full (legs equal to gage of lighter member) continuous fillet weld, or one full chain intermittent fillet weld or one staggered full intermittent fillet weld with 50 per cent discontinuities.

0.070-inch for two full continuous fillet welds or one 60-degree single-V open-root butt weld.

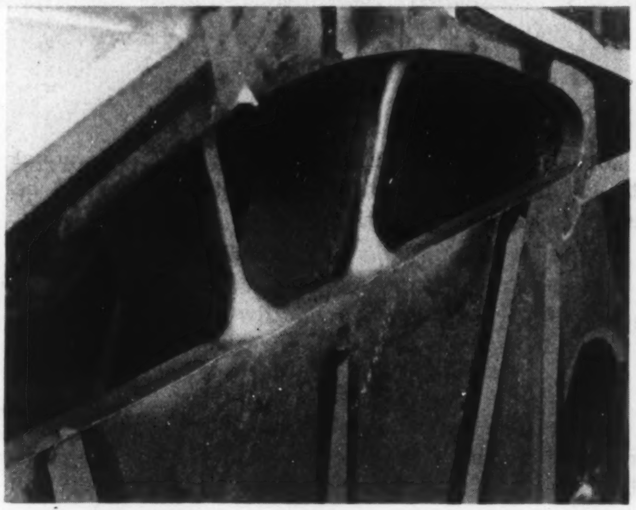
Average longitudinal shrinkage per joint:

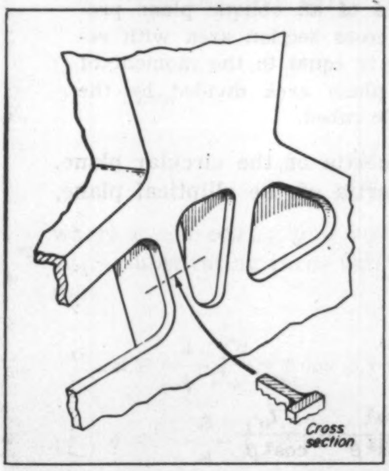
0.03 per cent of joint length for joints having 0.025-inch transverse shrinkage.

0.10 per cent of joint length for joints having 0.070-inch transvere shrinkage.

Warpage effects on final tolerances must be largely overcome by proper design to compensate for probable warpage to be expected in welding.

Fig. 27—Below—End plate of a diesel engine frame in which distress, evident in these secondary joints, was eliminated by adequate fairing-in with weld metal





Cross section

Fig. 28 — Left — An abrupt change in section of the design shown in Fig. 27 is avoided at the expense of a slight reduction in the opening area

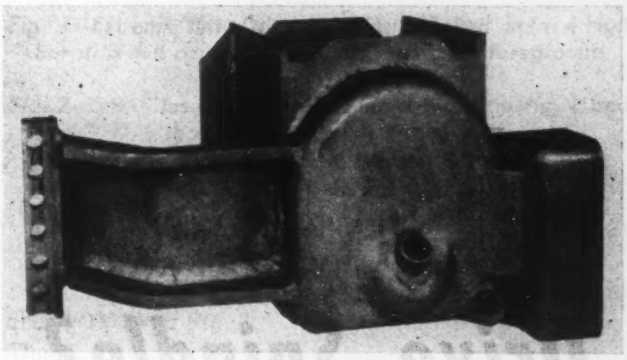
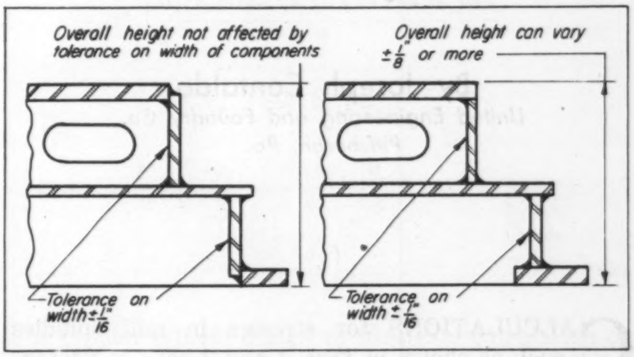


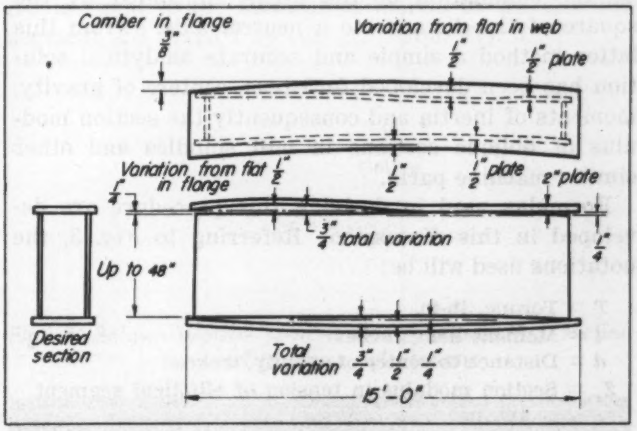
Fig. 29—Above—Journal box designed to utilize castings, forgings, pressings and torch-cut bars. A minimum number of parts are employed with physicals to suit, the top member being a forging of greater hardness to resist peening forces from the bearings

Fig. 30—Below—Simple example of weldment emphasizing the effect of individual part tolerances on the final obtainable accuracy in the finished unit



Overall height not affected by tolerance on width of components
Overall height can vary ± 1/8 or more
Tolerance on width ± 1/16"
Tolerance on width ± 1/16"

Fig. 31—Below—An example of possible effects of natural tolerances on weldment. Regular mill tolerances on plate, shapes, etc., as well as cutting and fitting tolerances must be considered



Camber in flange
3/8"
Variation from flat in web
1/2"
1/2" plate
Variation from flat in flange
1/2"
1/4"
1/2"
1/2" plate
2" plate
3/4 total variation
1/4"
Up to 48"
Desired section
Total variation
3/4"
1/2"
1/4"
15'-0"

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Air Reduction Sales Co. .... New York, N. Y.
American Car & Foundry Co., Welded Products Div. (Figs. 18, 23, 29) .... Berwick, Pa.
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General Electric Co. .... Schenectady, N. Y.
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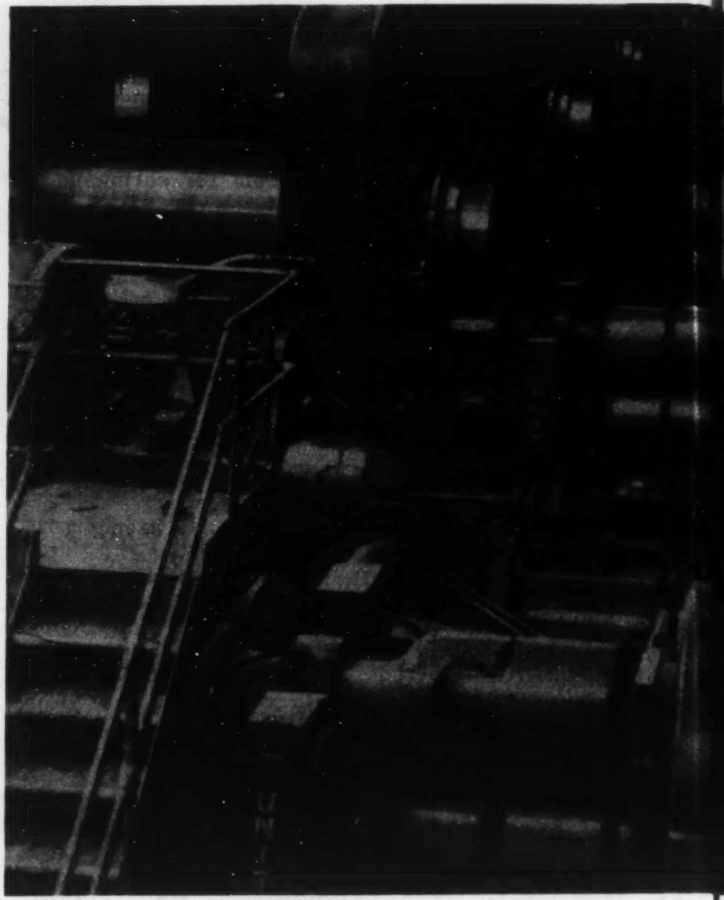
Lukens Steel Co. (Figs. 20, 22, 24, 26, 27, 28, 30 and 31) .... Coatesville, Pa.
Westinghouse Electric Corp. .... Pittsburgh, Pa.

What Size Drive Spindle?

. . . a useful short cut in selecting required mill spindle diameter

By Joseph Contaldo
United Engineering and Foundry Co.
Pittsburgh, Pa.



CALCULATIONS for stresses in mill spindles such as shown in *Figs.* 1 and 2 have heretofore been made by one of several approximate and prolonged methods. One such system involves dividing the cross section of the projected area into small strips, and then determining the moment of inertia by the summation of the areas multiplied by the square of the distance to a neutral axis. From this latter method a simple and accurate analytical solution has been developed for areas, centers of gravity, moments of inertia and consequently the section modulus of oblique sections in mill spindles and other similar machine parts.

Formulas used in deriving this procedure are developed in this discussion. Referring to *Fig.* 3, the notations used will be:

T = Torque, lb-in.
t = Moment arm, inches
d = Distance to center of gravity, inches
Z_T = Section modulus in tension of elliptical segment AC, in.^{3}
Z_C = Section modulus in compression of elliptical segment AC, in.^{3}
S_1 = Compressive stress, psi
S_2 = Tensile stress, psi.

From *Fig.* 4, there exists a relationship between the area of the circular plane HJ and the elliptical plane KJ that may be defined as:

> The area of an oblique plane projected from a uniform cross section area is equal to the area of the vertical plane divided by the cosine of the oblique angle.

Let A, the area of the circular plane HJ, be equal to πa^2 and A_E, the area of the elliptical plane KJ, be equal to πab. Substituting

$$b = \frac{a}{\cos\beta}$$

then

$$A_E = \frac{\pi aa}{\cos\beta} = \frac{A}{\cos\beta}$$

There also exists a relationship between the moment of inertia of the circular plane HJ and the elliptical plane KJ that may be defined as follows:

> The moment of inertia of an oblique plane projected from a uniform cross section area with respect to a common axis is equal to the moment of inertia of the vertical plane area divided by the cosine of the oblique angle cubed.

Let I = moment of inertia of the circular plane, and I_E = moment of inertia of the elliptical plane, then

$$I = \frac{\pi a^4}{4}$$

and

$$I_E = \frac{\pi ab^3}{4}$$

$$I_E = \frac{\pi aa^3}{4\cos^3\beta} = \frac{I}{\cos^3\beta}$$

Fig. 1—Extreme left—Drive spindles installed in a 4-high hot strip mill can be seen right center and foreground

Fig. 2—Left—Close-up view of spindles shown in Fig. 1 and shown in the sketch in Fig. 3

This formula is the basis of the spindle calculation, and will be referred to later.

Derivation of the formulas for area, center of gravity and moment of inertia of a circular segment will be obtained from *Fig.* 5. Note that ϕ is expressed in radians when used without a trigonometric function. Let A = area of circular segment = area of sector *ORST* minus area of triangle *ORT* using *Fig.* 3. Then

$$A = \frac{r^2}{2}\,2\phi - \frac{2r^2 \sin\phi \cos\phi}{2}$$

$$A = \frac{r^2}{2}\,(2\phi - \sin 2\phi) \qquad (1)$$

Let d = center of gravity of circular segment from *OY*. Then

$$d = 2\int_{x_1}^{r} \frac{xy\,dx}{A}$$

where $x = r\cos\phi_1$, $y = r\sin\phi_1$ and $dx = -r\sin\phi_1\,d\phi_1$. Substituting these values in the foregoing equation,

$$d = \frac{2}{A}\int_{\phi}^{o}(-r\cos\phi_1)\,(r\sin\phi_1)\,(r\sin\phi_1 d\phi_1)$$

$$d = -\frac{2}{A}\int_{\phi}^{o} r^3\cos\phi_1\sin^2\phi_1\,d\phi$$

$$d = \frac{2}{3A}\,r^3\sin^3\phi \qquad (2)$$

Let I_{OY} = moment of inertia of circular segment about *OY* from *Fig.* 3. Then

$$I_{OY} = 2\int_{x_1}^{r} x^2\,y\,dx$$

where $x = r\cos\phi_1$, $dx = -r\sin\phi_1\,d\phi_1$ and $y = r\sin\phi_1$, as before.

$$I_{OY} = 2\int_{\phi}^{0} -r^4\cos^2\phi_1\sin^2\phi_1\,d\phi_1$$

$$= 2r^4\int_{\phi}^{0}\frac{(1+\cos 2\phi_1)\,(1-\cos 2\phi_1)\,d\phi_1}{4}$$

$$= -\frac{r^4}{2}\int_{\phi}^{0}(1-\cos^2 2\phi_1)\,d\phi_1$$

$$= -\frac{r^4}{2}\left[\frac{\phi_1}{2} - \frac{\sin 4\phi_1}{8}\right]_{\phi}^{0}$$

$$I_{OY} = \frac{r^4}{2}\left[\frac{\phi}{2} - \frac{\sin 4\phi}{8}\right] \qquad (3)$$

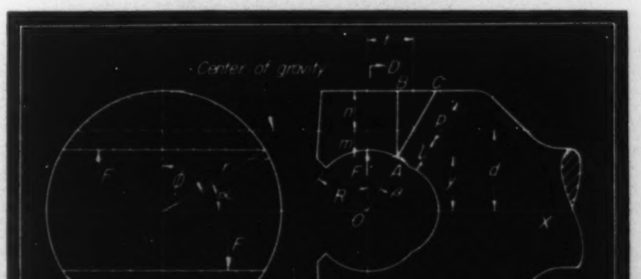
A typical spindle design to illustrate calculation of stresses in the section involved is shown in *Figs.* 2 and 3. The section *AB* is a circular segment with the projected section *AC* as the elliptical segment. From the law of the moment of inertia established previously, the moment of inertia of the elliptical segment *AC* is equal to the moment of inertia of the circular segment *AB* divided by $\cos^3\beta$. From *Fig.* 3,

$$R = r\sin\alpha$$

$$\cos\beta = \frac{y}{r\sin\alpha}$$

$$\cos\phi = \frac{y}{r}$$

Fig. 3—Below—Typical spindle design illustrating section involved in stress calculations



$$\cos\phi = \frac{r \sin\alpha \cos\beta}{r}$$

$$\cos\phi = \sin\alpha \cos\beta \qquad (4)$$

$$P = \frac{n}{\cos\beta} = \frac{r - d}{\cos\beta} = \frac{r(1 - k_1)}{\cos\beta}$$

$$l = \frac{m}{\cos\beta} = \frac{d - y}{\cos\beta} = \frac{r(k_1 - \cos\phi)}{\cos\beta}$$

$$t = d \tan\beta \qquad (5)$$

$$F = \frac{T}{\frac{4}{3} r} \qquad (6)$$

From the common formula $S = Mc/I$

$$Ft = SZ \qquad (7)$$

Using Equation 3,

$$I_{OY} = \frac{r^4}{2}\left[\frac{\phi}{2} - \frac{\sin 4\phi}{8}\right]$$

Next, transfer the moment of inertia of the circular segment about its center of gravity, which will be

$$I_{CG} = I_{OY} - Ad^2$$

Applying the law of moment of inertia of an oblique plane gives

$$I_E = \frac{I_{OY} - Ad^2}{\cos^3\beta} \qquad (8)$$

which represents the moment of inertia of the elliptical segment *AC* about its center of gravity.

The section modulus in tension of the elliptical segment *AC* is

$$Z_T = \frac{I_E}{l} \qquad (9)$$

The section modulus in compression of the elliptical segment *AC* is

$$Z_C = \frac{I_E}{P} \qquad (10)$$

The curves in *Fig.* 6 were plotted with R/r ratios corresponding to an angle α of 15 to 45 degres and with angle $\beta = 30$ degrees, which is generally used in most cases.

EXAMPLE 1: Use of the curves is illustrated for a spindle where $\beta = 30$ degrees, $r = 13\frac{1}{2}$ inches and $R = 6\frac{3}{4}$ inches as follows:

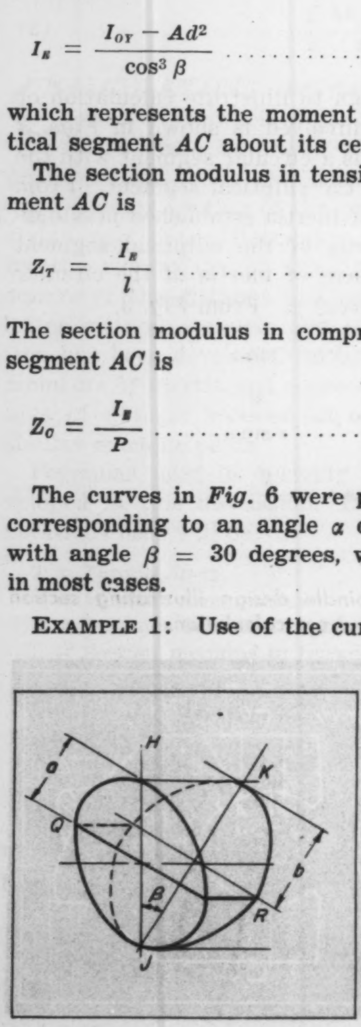


Fig. 4—Sketch showing relationship between vertical plane and oblique projected plane

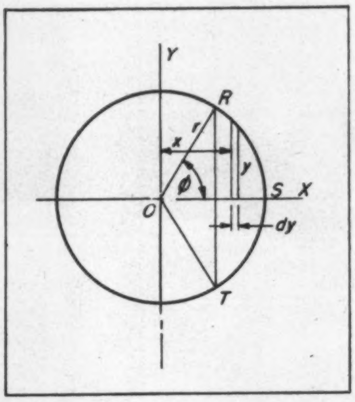


Fig. 5 — Diagram used in derivation of formulas for area, center of gravity and moment of inertia of circular segments

$$\frac{R}{r} = \frac{6.75}{13.50} = 0.5000$$

Referring to *Fig.* 6

$$d = k_1 r = 0.666 \times 13\tfrac{1}{2} = 8.99 \text{ in.}$$

$$I_E = k_2 r^4 = 0.0252\ (13\tfrac{1}{2})^4 = 836.6 \text{ in.}^4$$

$$Z_T = k_3 r^3 = 0.0935\ (13\tfrac{1}{2})^3 = 230 \text{ in.}^3$$

$$Z_C = k_4 r^3 = 0.0654\ (13\tfrac{1}{2})^3 = 160 \text{ in.}^3$$

$$t = k_5 r = 0.3848 \times 13\tfrac{1}{2} = 5.19 \text{ in.}$$

Stresses are then readily obtained from the well known equation $S = Mc/I = Ft/Z$.

For a spindle whose angle β is other than 30 degrees, use the following procedure.

EXAMPLE 2: $\beta = 35$ degrees, $r = 13\frac{1}{2}$ inches and $R = 6\frac{3}{4}$ inches. From Equation 4

$$\cos\phi = \sin\alpha \cos\beta$$

and since

$$\sin\alpha = \frac{R}{r} = 0.5000$$

$$\alpha = 30$$

then

$$\cos\phi = \sin 30 \cos 35$$

and

$$\log\cos\phi = \log\sin 30 + \log\sin 35$$

$$\phi = 65^\circ\ 49.3'$$

$$\phi = 1.14880 \text{ radians}$$

Using Equation 1,

$$A = \frac{r^2}{2}(2\phi - \sin 2\phi)$$

$$= \frac{r^2}{2}(2 \times 1.14880 - \sin 131^\circ\ 38.6')$$

$$A = 0.77515 r^2$$

From Equation 2,

$$d = \frac{2r^3 \sin^3\phi}{3A} = \frac{2r^3 \sin^3 65^\circ\ 44.3'}{3 \times 0.77515 r^2}$$

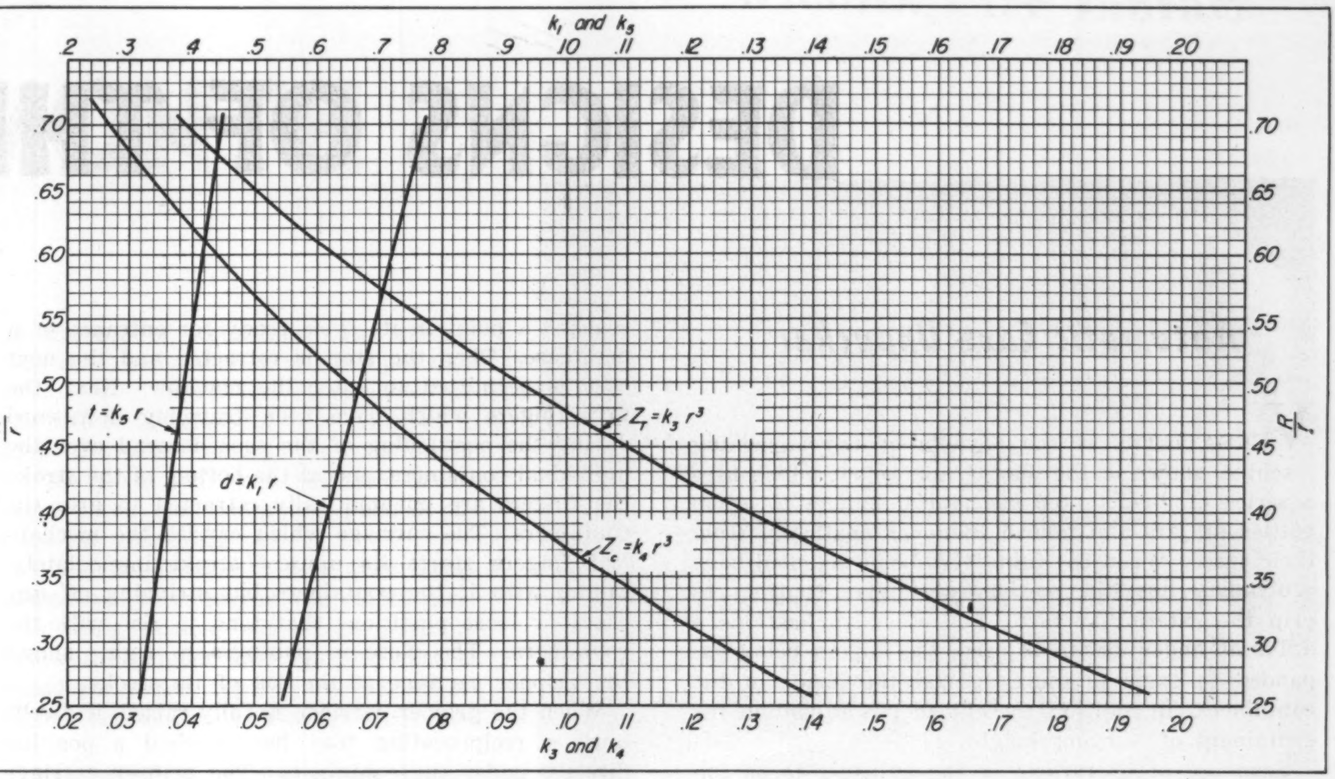


Fig. 6—Curves used in determining constants for use in formulas for moment arm, distance to center of gravity and section moduli of mill spindles

$$\log \frac{d}{r} = \log 2 + 3 \log \sin 65° \, 44.3' - \log 3 - \log .77515$$

$$= 0.30103 + 9.88039\text{-}10 - 0.47712 - \bar{1}.88939$$

$$= 9.81491\text{-}10$$

$$d = 0.6530r = 0.6530 \times 13.5 = 8.815 \text{ in.}$$

Substituting in Equation 3

$$I_{OY} = \frac{r^4}{2} \left[\frac{\phi}{2} - \frac{\sin 4\phi}{8} \right]$$

$$= \frac{r^4}{2} \left[\frac{1.14880}{2} - \frac{\sin 263° \, 17.2}{8} \right]$$

$$I_{OY} = 0.34927r^4$$

From Equation 8,

$$I_g = \frac{I_{OY} - Ad^2}{\cos^3 35} = \frac{0.34927r^4 - 0.77515r^2 \, (0.6530r)^2}{\cos^3 35}$$

$$= \frac{0.34927r^4 - 0.33053r^4}{(0.81915)^3} = \frac{0.01874r^4}{(0.81915)^3}$$

$$I_g = 0.03409r^4 = 0.3409 \, (13.5)^4 = 1132.3 \text{ in.}^4$$

$$P = \frac{r - d}{\cos 35} = \frac{r(1\text{-}0.6530)}{\cos 35} = \frac{0.3470r}{\cos 35}$$

$$\log \frac{P}{r} = \log 0.347 - \log \cos 35$$

$$P = 0.4236r$$

$$Z_C = \frac{I_g}{P} = \frac{0.03409r^4}{0.4236r} = 0.08048r^3 = 198 \text{ in.}^3$$

$$l = \frac{r(0.6530 - \cos 65° \, 49.3')}{\cos 35} = \frac{0.24342r}{\cos 35}$$

$$\log \frac{l}{r} = \log .24342 - \log \cos 35°$$

$$l = 0.2971r$$

$$Z_T = \frac{I_g}{1} = \frac{0.03409r^4}{0.2971r} = 0.11471r^3 = 282 \text{ in.}^3$$

$$t = d \tan \beta$$

$$= 0.6530r \tan 35$$

$$t = 0.4572r = 6.17 \text{ in.}$$

With the aid of the curves it is possible to reverse the foregoing procedure and calculate the diameter of a spindle head for a given stress, i.e., $Ft = SZ$ and

$$F = \frac{T}{\frac{4}{3}r}$$

where $t = k_5 r$, $Z_C = k_4 r^3$ and $Z_T = k_3 r^3$. Substituting these values,

$$\frac{3T}{4r} k_5 r = S_1 k_4 r^3 = S_2 k_3 r^3$$

from which

$$r = \sqrt[3]{\frac{k_5}{k_4} \left(\frac{3T}{4S_1} \right)}$$

or

$$r = \sqrt[3]{\frac{k_5}{k_3} \left(\frac{3T}{4S_2} \right)}$$

where S_1 denotes compressive stresses and S_2 indicates tensile stresses.

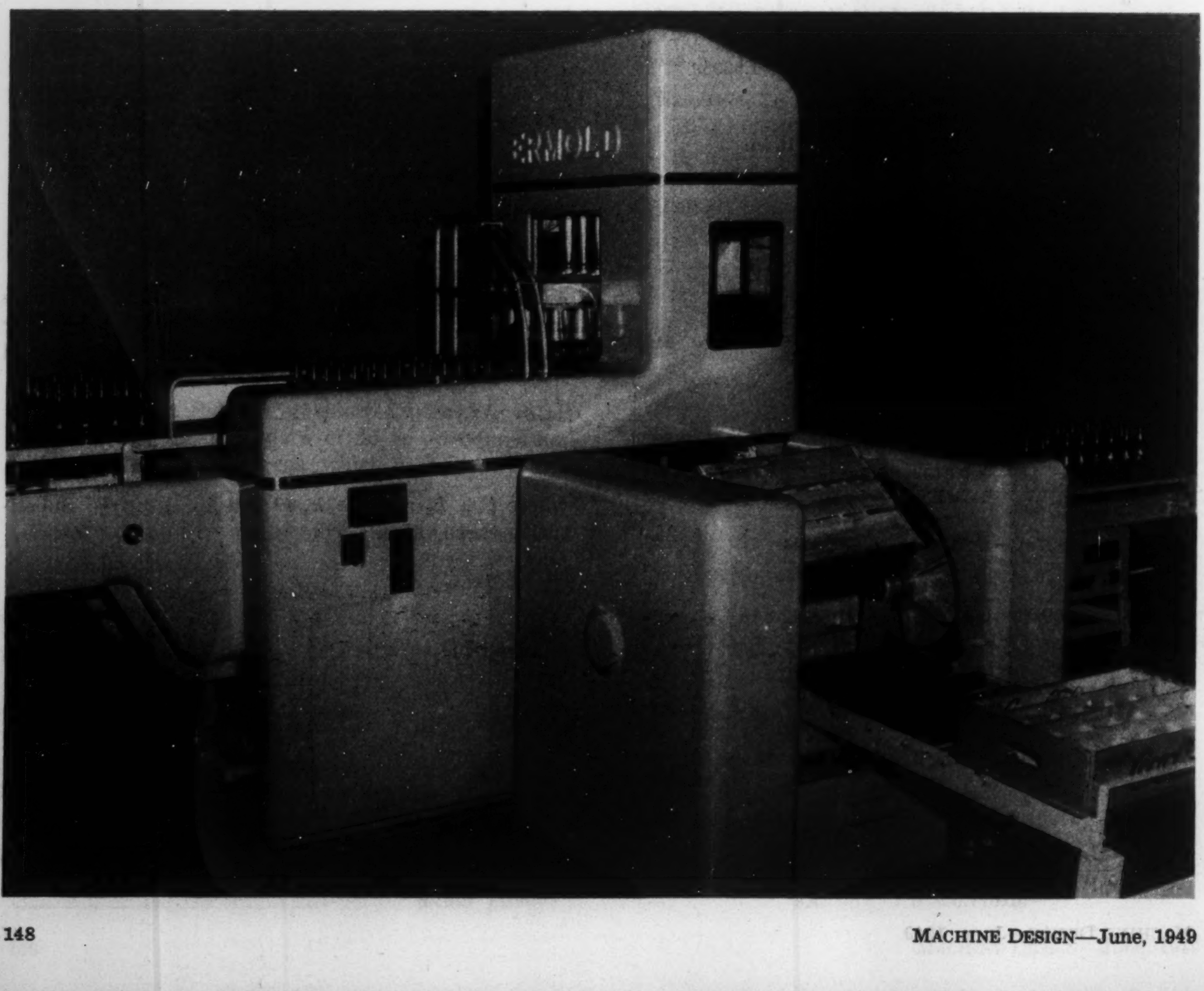
DESIGNS OF THE

Automatic Case Unpacker

VERSATILITY is the keynote of the unpacking machine, shown in the photograph below, which uses a series of air-actuated mechanical fingers to grasp bottles or jars and unload them automatically from their cases. When the containers being handled have protruding lips, the mechanical fingers contract to grip the exterior surface. For other applications a different finger design is used, the fingers being expanded to exert pressure against the inside of the containers. In addition, the unloader is adjustable for containers of varying height.

Sequence of operations in the unloader is as follows: As the open-top cases, cartons or trays approach the receiving end of the conveyor they are detained by a pneumatic stop until the machine has reached a point in its cycle ready for entrance of a new case. Then the stop is retracted and the next case is permitted to enter the machine. Next, the grip fingers which have been traveling downward during the positioning of the case descend over the individual containers, and at the bottom of the stroke the fingers are pneumatically retracted to grip the containers. The carriage which carries the mechanical fingers starts its upward stroke immediately, taking with it the containers but stripping off any cases or loose partitions that tend to rise with the containers. The close-up photograph, right, shows the gripper carriage at the top of its stroke.

When the gripper carriage is fully raised, it dwells until a reciprocating tray has reached a position directly under the containers. The gripper carriage then descends a short distance and places the containers on the tray, at which time the gripper fingers release their hold and the carriage again ascends



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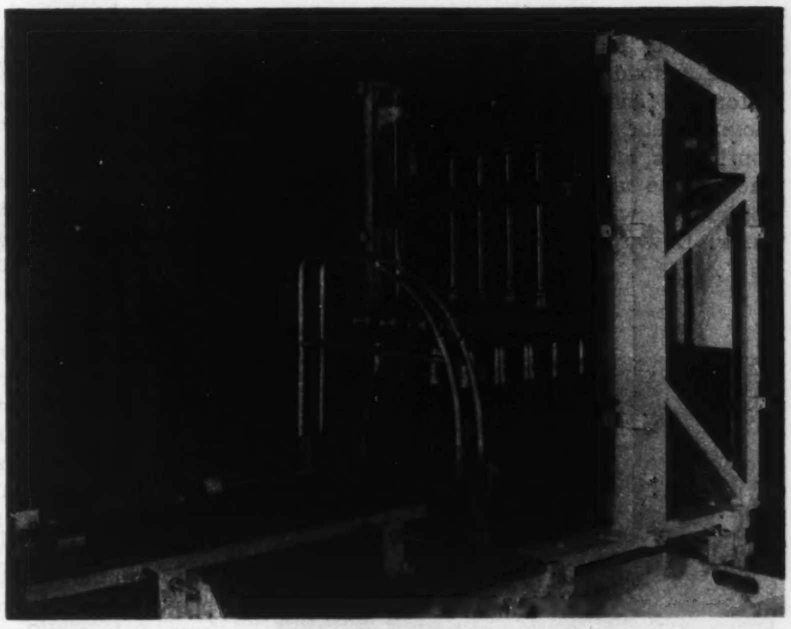
MONTH

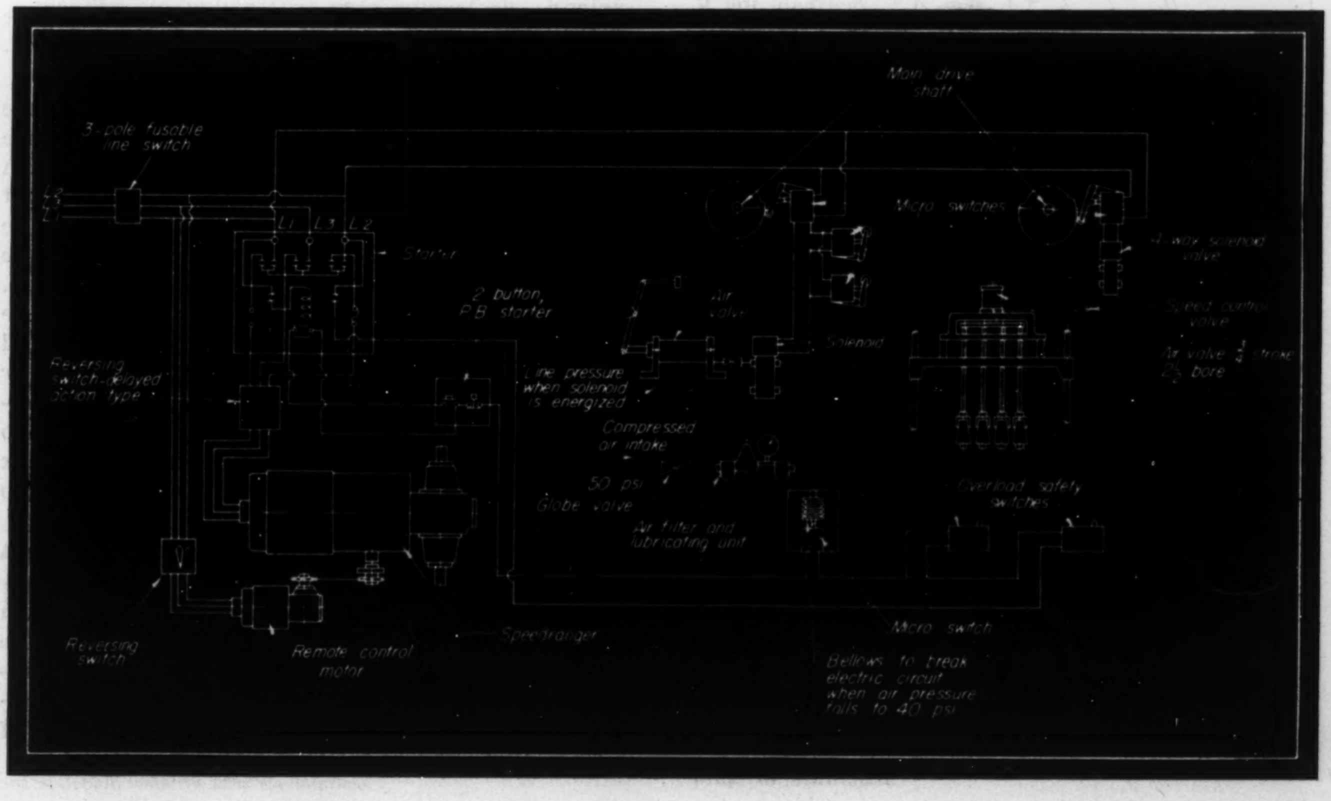
to the top of its stroke. The sliding tray now moves horizontally to a position over a steel mesh conveyor, shown at the left in the close-up view. A pivoted stop descends behind the containers on the tray, and when the tray is retracted the containers are pushed off onto the conveyor.

While the bottles or jars were being placed on the conveyor, the empty case was being pushed out of its position below the gripper carriage and onto a standard roller type conveyor, after which the entire unloading cycle repeats.

Powered by a 1½-horsepower motor, the unpacker uses compressed air to operate the cylinders which control the mechanical fingers and actuate the pneumatic case stop and positioner. The circuit diagram, below, shows the interrelation of the electrical and pneumatic circuits. Proper sequencing of the various functions is obtained through the use of adjustable timing cams mounted on the main drive shafts. Microswitches riding these cams control solenoid valves which operate gripper fingers and case positioners.



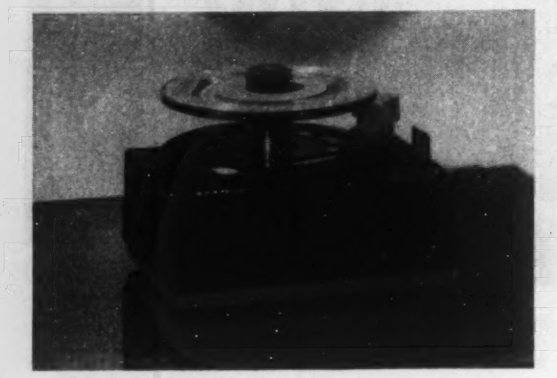
Another set of cams on the same shafts control the sliding tray, which is reciprocated horizontally by means of a rack and gear arrangement, and the gripper carriage which is reciprocated vertically by a counterbalanced roller chain. This chain is provided with adjusting and locking nuts above and below the gripper carriage for vertical adjustment of the height

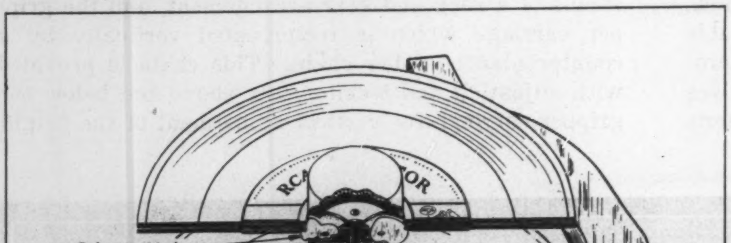

3-pole fusable line switch
L2
L3
L1
L1 L3 L2
Starter
2 button, P.B. starter
Reversing switch-delayed action type
Line pressure when solenoid is energized
Compressed air intake
50 psi
Globe valve
Air filter and lubricating unit
Reversing switch
Remote control motor
Speedranger
Main drive shaft
Micro switches
Air valve
Solenoid
4-way solenoid valve
Speed control valve
Air valve ¾ stroke 2½ bore
Overload safety switches
Micro switch
Bellows to break electric circuit when air pressure falls to 40 psi

of carriage to permit accommodation of any height of container within the range of the machine. The close-up photograph shows the pneumatic cylinder used to actuate the mechanical grippers, the tracks on which the tray slides, and the counterbalanced roller chain that controls movement of the gripper carriage.

The unloader shown here includes an automatic case dumper installed for removing debris from empty cases. Under continuous breakdown tests, the case unpacker has unloaded over 2 million glass containers with no breakage. Manufacturer: Edward Ermold Co., New York 14, N. Y.

Center-Spindle Record Changer





ELIMINATING the need for outside record supports, the new record changer shown in the photograph, left, encloses the entire drop mechanism in the 1½-inch diameter center turntable spindle. On the outside of this spindle are two retractable shelves which support the record stack. During the record-dropping action, the shelves are retracted within the spindle and simultaneously two changer blades move out of slots in the spindle, just above the shelves, and into the air space between records provided by raised shoulders in the label areas. This provides temporary support for all the records stacked above the bottom one. As the bottom record drops to the turntable, the changer blade recedes into the spindle and the retractable shelves emerge to again support the unplayed records.

Driving of the selector blades and support shelves is accomplished through a drive gear and drive shaft that are controlled by the main cam of the change mechanism (not shown in the accompanying drawings at the left). In the top sketch the mechanism is shown in position halfway through the record-changing cycle. The selector blades have emerged into position under the record stack while the support shelves have receded into the center spindle and have allowed the bottom record to drop to the turntable. In the bottom sketch, the changer is shown after having completed the change cycle, with the support shelves out and the selector blades retracted.

During the playing interval, the main drive gear and the two drive pinions rotate around the axis of the drive gear. Fixed on the lower end of the drive gear shaft, which extends below the spindle, is a star wheel. When the record-tripping action begins, this star wheel is engaged by a lever that holds the drive gear in a stationary position, and the continued rotation of the spindle causes the drive pinions to rotate. A cam located under and attached to the turntable controls the timing of the mechanism that holds the star wheel during the spindle rotation required to change records.

Selector cams controlling movement of the selector blades and support shelves are mounted on the upper end of the drive pinion shafts within an opening in the support shelves. The selector blades are fixed to the tops of the eccentric selector cams above the support shelves. As the drive pinions rotate, the cams move toward the center of the spindle, carrying the support shelves inward and at the same time rotating the selector blades outward. Further rotation of the eccentric cams returns the support shelves to the outermost position under the record stack and withdraws the selector blades back into the spindle.

The retractable shelves are tapered from a flat, protruding top surface to a lower section that is flush with the spindle. When records are removed from the turntable, the slight pressure of the center hole edges automatically depresses the shelves to permit passage. Manufacturer: RCA Victor Division of Radio Corp. of America, Camden, N. J.

Selecting Steel Arc-Welding Electrodes*

CONTINUALLY expanding application of welding in machinery design has served to emphasize the need for adequate consideration of the type of welding electrode to be used. With well-engineered weldments, the type of electrode as well as the size, joint preparation, type and size of weld, procedure, and similar necessary information should be specified on the drawings. In the accompanying table, the various arc-welding electrodes which have been standardized by the American Welding Society and the American Society for Testing Materials are given along with other pertinent application data.

The joint specifications issued (ASTM A233-48T and A316-48T, also AWS A5.1-48T and A5.5-48T) cover six basic strength groups. Standard classification numbers are keyed for easy identification in a manner not unlike that used with steels. For example, an E7020 electrode has the following characteristics:

The letter E denotes a metal arc welding electrode; the first two digits, 70, indicate the tensile strength in one thousand psi units on all-weld metal tensile tests; the third digit indicates the suitable welding positions—1 for all-position, 2 for flat and horizontal, and 3 for flat position only — in which the electrode can be used; and the fourth digit indicates the type or types of current which can be used. The digits for current are as follows:

0......	For use with direct current reversed polarity, electrode positive only
1......	For use with alternating or direct current, reversed polarity, electrode positive
3......	For use with alternating or direct current, straight polarity, electrode negative
5......	For use with direct current, reversed polarity, electrode positive only
6......	For use with alternating or direct current, reversed polarity, electrode positive

Characteristics of deposited weld metal are specified only by means of mechanical properties. In weldments where mechanical properties are the only requirements, whether as-welded or stress-relieved, other characteristics are of little importance. In weldments to be heat treated, however, consideration must be given to depositing metal with thermal characteristics comparable to those of the base metal. In selecting electrodes, therefore, the attempt should be made to insure this result. Because some alloying elements cannot be effectively transferred across the arc, it is necessary to substitute other transferable elements that can be deposited with the proper alloying effect. These are usually added to the deposit through the electrode covering. Electrodes, regardless of tradename, which meet the requirements of any given classification may be expected to have all major characteristics which are similar if not identical.

If weld metal of a given composition is necessary, the available electrodes must be studied to determine which will be satisfactory. Electrodes classified as E70 series, for instance, will deposit weld metal with approximately 0.50 per cent molybdenum. Alloys containing molybdenum usually possess increased creep resistance at elevated temperatures and for this reason these alloys are widely used for fabricating high-temperature and high-pressure units.

Most weldments made with low-alloy electrodes are stress relieved before placing in service and for this reason the weld metal properties are designated in the stress-relieved condition. It is not necessary that all weldments be stress relieved to give satisfactory service. However, for maximum ductility and impact properties with electrodes having conventional coverings, stress relief should be used.

Electrode sizes are: 1/16-inch diameter by 9 or 18-inch lengths; 5/64 and 3/32-inch diameter by 12 or 18-inch lengths; ⅛ and 5/32-inch diameter by 14-inch length; 3/16-inch diameter by 14 or 18-inch lengths; and 7/32, ¼, 5/16, and ⅜-inch diameters by 18-inch length. Electrodes may be furnished in reels also. For the 18-inch lengths of 1/16, 5/64 and 3/32-inch electrodes, center gripping is standard; on all others end gripping is standard.

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* Based on American Welding Society and American Society for Testing Materials tentative joint specifications.

ENGINEERING DATA SHEET

STANDARD ELECTRODES AND APPLICATIONS

AWS-ASTM Classification	Electrode Coating	Ten. Str.* (psi, min)	Yield Pt. (psi, min)	Elong. (% in 2-in., min)	Applications
Mild Steel					
E4510	Sulcoated or	45,000	not specified	5	General all-purpose for noncritical and relatively unstressed welds in mild steels. Plain low-carbon steel core wire.
E4520	light coated	45,000	not specified	5	Similar to E4510. Used for light-gage tanks and drums, and automotive frames and parts.
E6010	High cellulose sodium	62,000	52,000	22	General all-purpose for mild steels and particularly multiple-pass work. Good for galvanized plate and some low-alloy steels under ¼-inch in thickness. Core wire is usually rimmed steel of 0.10 to 0.14 carbon, 0.40 to 0.60 manganese, 0.04 max sulphur and phosphorous, and 0.025 max silicon.
E6011	High cellulose potassium	62,000	52,000	22	Similar characteristics to E6010. For mild steels.
E6012	High titania sodium	68,000	55,000	17	For mild steels. Recommended for single-pass, high-speed, high-current horizontal fillet welds and for poor fit-up. Good for low-alloy steels, particularly of higher carbon varieties. Core wire similar to E6010.
E6013	High titania potassium	68,000	55,000	17	For general purpose welding of mild steels, especially light sheet metal work. Similar to E6012.
E6015	Low hydrogen sodium	68,000	55,000	22	For welding high-strength, high-carbon, alloy steels with little or no preheat. Also for high-sulphur steels. Used on armor plate, malleable iron spring steels, and enameling steels. Rimmed steel core wire.
E6016	Low hydrogen potassium	68,000	55,000	22	Similar to E6015.
E6020	High iron oxide	62,000	52,000	25	For deep-fillet welding in mild steels. Core usually 0.10 to 0.14 carbon steel. Used for pressure vessels, heavy machine bases, and structural parts where section thickness permits.
E6030	High iron oxide	62,000	52,000	25	Similar to E6020 but has higher deposition rates. Primarily for narrow groove welds. Core usually 0.10 to 0.14 carbon steel. For welding heavy plate in flat position only.
Low Alloy Steel					
E7010	High cellulose sodium	70,000	57,000	22	Generally recommended for all-position work where deposit quality is important, particularly on multiple pass work. Core usually of rimmed steel containing 0.10 to 0.14 per cent carbon, 0.40 to 0.60 per cent manganese, 0.04 per cent max sulphur and phosphorous, and 0.025 per cent max. silicon. Alloys added through covering.
E7011	High cellulose potassium	70,000	57,000	22	Core similar to E7010 series with alloys added through covering. Perform satisfactorily on galvanized plate.
E7013	High titania potassium	70,000	57,000	18	Originally designed for light sheet metal work. Radiographic weld qualities are usually good.
E7015	Low hydrogen sodium	70,000	57,000	22	Usually rimmed steel core. Developed for welding high-strength, high carbon, alloy steels without underbead cracking ordinarily encountered with ordinary electrodes.
E7016	Low hydrogen potassium	70,000	57,000	22	Similar to E7015 series.
E7020	High iron oxide	70,000	57,000	25	Good for high-current deep-fillet welding of heavy plate. Usually 0.10 to 0.14 per cent carbon steel core.
E7025	Low hydrogen sodium	70,000	57,000	25	Not commercially available as yet.
E7026	Low hydrogen potassium	70,000	57,000	25	Not commercially available as yet.
E7030	High iron oxide	70,000	57,000	25	Similar to E7020 series but has higher deposition rate. Designed primarily for use in narrow-groove butt welds. Core wire 0.10 to 0.14 per cent carbon steel.
E8010	High cellulose sodium	80,000	67,000	19	Similar to E7010.
E8011	High cellulose potassium	80,000	67,000	19	Similar to E7011.
E8013	High titania potassium	80,000	67,000	16	Similar to E7013.
E8015	Low hydrogen sodium	80,000	67,000	19	Similar to E7015.
E8016	Low hydrogen potassium	80,000	67,000	19	Similar to E7016.
E8020	High iron oxide	80,000	67,000	22	Similar to E7020.
E8025	Low hydrogen sodium	80,000	67,000	22	Similar to E7025.
E8026	Low hydrogen potassium	80,000	67,000	22	Similar to E7026.
E8030	High iron oxide	80,000	67,000	22	Similar to E7030.
E9010	High cellulose sodium	90,000	77,000	17	Similar to E7010.
E9011	High cellulose potassium	90,000	77,000	17	Similar to E7011.
E9013	High titania potassium	90,000	77,000	14	Similar to E7013.
E9015	Low hydrogen sodium	90,000	77,000	17	Similar to E7015.
E9016	Low hydrogen potassium	90,000	77,000	17	Similar to E7016.
E9020	High iron oxide	90,000	77,000	20	Similar to E7020.
E9025	Low hydrogen sodium	90,000	77,000	20	Similar to E7025.
E9026	Low hydrogen potassium	90,000	77,000	20	Similar to E7026.
E9030	High iron oxide	90,000	77,000	20	Similar to E7030.
E10010	High cellulose sodium	100,000	87,000	16	Similar to E7010.
E10011	High cellulose potassium	100,000	87,000	16	Similar to E7011.
E10013	High titania potassium	100,000	87,000	13	Similar to E7013.
E10015	Low hydrogen sodium	100,000	87,000	16	Similar to E7015.
E10016	Low hydrogen potassium	100,000	87,000	16	Similar to E7016.
E10020	High iron oxide	100,000	87,000	18	Similar to E7020.
E10025	Low hydrogen sodium	100,000	87,000	18	Similar to E7025.
E10026	Low hydrogen potassium	100,000	87,000	18	Similar to E7026.
E10030	High iron oxide	100,000	87,000	18	Similar to E7030.

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* Tensile strength and ductility requirements for electrodes of the E70XX classes and above are in the stress-relieved condition.

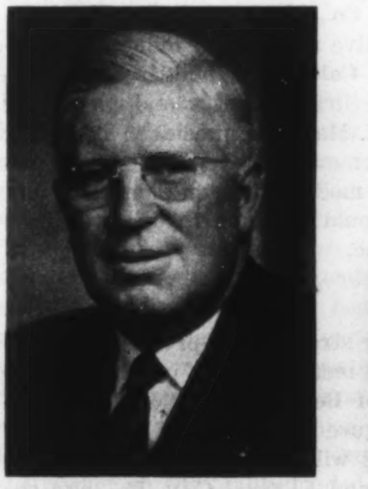
Men OF MACHINES

Harry C. Dumville has been named director of the New Devices Section of General Motors Corp., Detroit, Mich. Assistant director of the section since 1944, he succeeds **John H. Hunt** who is retiring. Mr. Dumville attended Rensselaer Polytechnic Institute, Troy, N. Y., and received his engineering degree from Tri-State College, Angola, Ind. He joined General Motors in 1934 as a junior engineer in the research laboratories and was transferred to the new devices section in 1936. In 1943 he was assigned to aircraft work in the Fisher Body Central Engineering staff, and in 1944 returned to the new devices section as assistant director.

Harry C. Dumville

J. H. Tredinnick has been named vice president of E. W. Bliss Co., Detroit. He is manager of the company's Hastings, Mich., plant, which specializes in the manufacture of small and medium-sized punch presses and high-production presses. Mr. Tredinnick joined Bliss in 1935 to take charge of this plant. For the previous six years he was factory manager of the V. & O. Press Co., Hudson, N. Y. Prior to joining V. & O. he was associated with the Lanston Monotype Machine Co., Philadelphia.

Philip Finale has joined Loewy Construction Co. Inc., Rolling Mill Division of Hydropress Inc., New York as chief engineer. After attending Carnegie Institute of Technology, Mr. Finale joined the 2nd Canadian Division during World War I. Upon returning from France he resumed his studies, graduating from Carnegie Institute in mechanical engineering. Mr. Finale has been associated with the Mesta Machine Co. since 1928 where he held the positions of rolling mill designer and proposal engineer until 1939. At the outbreak of World War II he assisted the company in the development of a special plant for the U. S. Army. Upon completion of this project he became rolling mill department engineer, which post he held until he joined Loewy Construction Co.



J. H. Tredinnick

Philip Finale

Elwood M. Keifer has recently been promoted to chief draftsman of Snyder Tool & Engineering Co., Detroit. He came to Snyder in 1945 as a designer, prior to which he was staff engineer with Chevrolet.

Western Electric Co. has announced the appointment of **Arthur B. Goetze** as works manager of the company's Tonawanda plant in Buffalo, N. Y., the 42nd St. Shops in New York City, and the Allentown, Pa., plant. Mr. Goetze replaces **William K. Wiggins** who is retiring.

Lincoln Electric Co. has announced the election of three additional members to its Board of Directors. They are **C. F. Clipsham**, assistant to the president, **William**

Irrgang, director of plant engineering, and **L. K. Stringham**, director of welding development.

◆

F. E. Baker has been named manager of the specialty transformer department of the Westinghouse Transformer Division, Sharon, Pa. In his new position Mr. Baker will be responsible for development, manufacturing of transformers for control, radio and radar, machine tools, electronic heating, railway signalling and similar general purpose and specialty applications.

◆

According to a recent announcement **G. V. Slottman** has been appointed director of research and engineering for Air Reduction Co., Inc., New York. Dr. Slottman has served Air Reduction in various capacities since 1934, prior to which he was chief combustion engineer and iron works manager for the United Steel Companies, Ltd., Sheffield, England.

◆

Appointment of **Llewellyn S. Howe** as director of engineering at the manufacturing plant of the Glenn L. Martin Co. Chemicals Div., Painesville, O., has been announced.

◆

Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, has announced the appointment of **J. P. Vederko** as works manager to succeed **E. J. McSweeny**, formerly vice president in charge of manufacturing. Mr. Vederko was formerly general superintendent of the Cross Co., Detroit. Prior to this association he spent eight years with Ex-Cell-O Corp., Detroit, in various production and engineering capacities. In his new position he will be in charge of all manufacturing operations which includes the production of hydraulic presses for metal working and process industries, metal die casting machines, plastics molding machinery and a full line of hydraulic power equipment.

◆

A. C. Moore has been appointed vice president of manufacturing, Ford International Inc., Detroit. He resigned as factory manager of the Plymouth Motor Division to join the Ford organization, and has been associated with Chrysler Corp. in Chicago and Detroit since 1943.

◆

Walter F. Benning was recently appointed chief engineer of Willys-Overland Motors, Toledo, and **Philip C. Johnson** was named assistant chief engineer. Prior to joining Willys-Overland in 1944 as truck engineer, Mr. Benning had been with Mack Truck, Allentown, Pa. For the past two years he has been technical assistant to the vice president in charge of engineering. Mr. Johnson was associated with Hudson Motor Car Co., Detroit, before coming to Willys-Overland in 1937. For the past four years he has been assistant to the vice president in charge of engineering.

News of Manufacturers

Desire to insure an adequate supply of mechanical engineers has prompted the **George Gorton Machine Co.** to found the George Gorton Scholarship in Mechanical Engineering. Several colleges already have agreed to accept the recipients of the award. Aptitude, personality, intelligence and the finer psychological values are studied to determine qualifiers. Two of the working periods of the four-year course are spent at the Gorton plant with the hope that the student will follow his professional career there, but no attempt is made to hold him if he should desire employment elsewhere upon completion of his education. The scholarship is limited to high school students of Racine, Wis., the location of the sponsor's plant.

◆

Economy through centralization has prompted the **F. L. Jacobs Co.**, manufacturers of automotive parts, Coca-Cola vending machines and Launderall home laundries to close operations performed in its Indianapolis, Ind., and Louisville, Ky., divisions and to transfer these operations to its Detroit and Traverse City, Mich., plants.

◆

Lake City Malleable Co. of Cleveland has placed into service a traveling exhibit of its processes and products. Housed in the body of a White bus, sample parts, models, and photographs illustrate the production of malleable iron castings from blueprint to finished part. Also included are "before and after" examples of design improvements to facilitate production. The exhibit will visit plants using malleable castings, affording engineers and others an opportunity to become more fully acquainted with the process and its potentialities.

◆

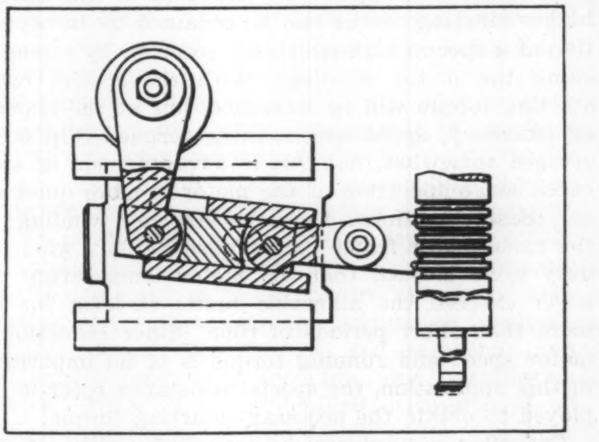
Two pioneer Detroit firms have been united, **Snyder Tool and Engineering Co.**, builder of production machines for the automotive and similar industries, having purchased **Arthur Colton Co.**, builder of production machines for the drug, plastics and packaging industries. Howard N. Maynard, president of Snyder Tool, announced that manufacturing operations will be transferred to the modern Snyder plant but that the new subsidiary would continue to operate under the Arthur Colton name.

◆

Twofold program for streamlining production facilities and expanding the merchandising program of the **Norge-Heat Division of Borg-Warner Corp.** has been announced. Manufacture of all types of warm-air home heating products will be consolidated in plants at Kalamazoo, Mich., and Ellwood City, Pa., and the division's plant at Hammond, Ind., will be closed.

Noteworthy Patents

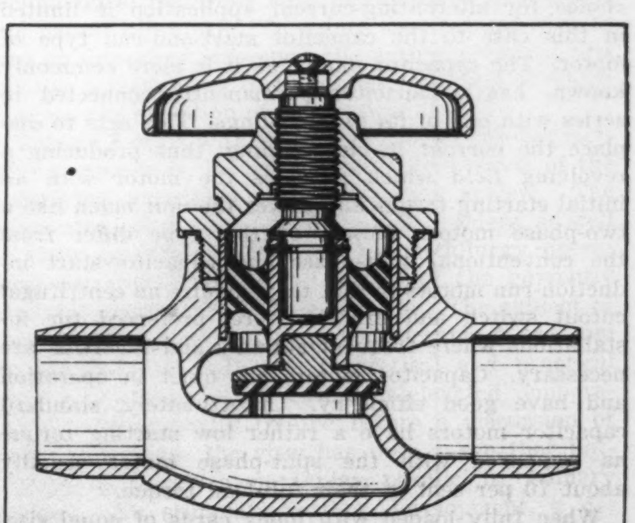
STROKE VARIATION during machine operation is possible with the reciprocating drive mechanism covered in patent 2,464,961. Specifically devised for such machines as gear shapers, the mechanism permits the cutting of gears with unequal tooth widths where it is necessary to change the length of stroke to suit the width of tooth being cut. Reciprocation is effected by means of an eccentric link which drives a pivoted sector arm meshing with a rack on the reciprocating member. Use of a pivoted, sliding connecting link between the sector and eccentric arms permits changing the length of stroke transmitted. Variations in cutter stroke can be timed to a specific work cycle by gearing the pivoted slide directly into the work spindle drive. Fellows Gear Shaper Co. has been assigned the patent by Arthur I. Bean.



LATERAL DISPLACEMENT of fluid-pressure type bearing journals under severe loading conditions is prevented by a new system which automatically amplifies the pressure differentials created. Normally, a very small displacement of a journal does not produce the necessary pressure differential to oppose suddenly applied transient loads on the journal. Patent 2,459,826 describes a bearing whose pressure pockets are connected to a series of balancing valves which are responsive to pressure changes in the various pockets and act in such a manner as to amplify any pressure differential which might occur. Sudden loading of the journal will increase the pressure in the pocket on the highly loaded side and decrease the pressure in the opposite pockets, thus tending to continuously center the journal in the bearing. Mario E. Martellotti has assigned the patent to the Cincinnati Milling Machine Co.

TWO-WAY RATCHET mechanism, disclosed in patent 2,443,744, allows normal ratcheting action in either direction of rotation or positive locking against rotation in both directions. The mechanism employs a three-position compound ratchet pawl and a single locking wheel having two sets of ratchet teeth cut in opposite directions. In use, by positioning the pawl in the proper longitudinal position, ratcheting in either direction or complete locking is obtained.

ELIMINATING PACKING LEAKAGE the packless globe valve covered in patent 2,457,472 utilizes a combined sealing element and spring of bonded rubber. A metal sleeve held snugly between the valve body and bonnet is separated from the hollow valve stem by a diaphragm of rubber or thermosetting material bonded to both the outer sleeve and the valve stem. Turning the valve handle rotates the operating stem in the hollow valve stem, thereby distorting the rubber body and seating the valve. Turning the operating stem in the reverse direction permits the rubber sleeve to pull the valve stem back to the open position. George H. Hufferd and George O. R. Lindgren have assigned the patent to the Weatherhead Co.



Fractional-Horsepower Motors

(*Concluded from Page* 129)

in either direction by the operator to deliver the desired card for ready posting, reference, removal or replacement. A phantom view of the motor-drive arrangement is shown in *Fig.* 2.

For the most part, these files are powered by motors designed to operate from 115-volt 60-cycle power sources. Requirement for instantaneous reversibility during rotation immediately limits the choice of motor to either a nonsynchronous capacitor start-and-run motor or a series-wound reversible motor. From a performance standpoint, either motor could be designed to operate satisfactorily. The series-wound motor has exceptionally high starting torque, and can be used on either alternating or direct current.

Unfortunately, however, certain other characteristics of this motor prevent its consideration as the best motor for the job. Of these, since the machines would normally be required to operate in relatively quiet atmospheres, the characteristic whine of the series-wound motor would undoubtedly offer the most serious objection. This whine is due to the high speed at which the motor operates and is caused by the brushes riding over the surface of the commutator.

Series motors are extremely sensitive to changes in load, and tend to decrease in speed with increase in load, and vice versa. Since the load, and thus the speed, will fluctuate with removal or addition of record cards and since relative speed constancy is a desirable feature, this characteristic also rules out consideration of the series motor for this particular application. In addition, except for very light loads, use of the common salient-pole series-motor is not advisable for service involving frequent starts. Under these conditions, brushes and commutators wear rapidly and require frequent replacement.

Is Limited to Capacitor Types

In view of the foregoing considerations, the motor choice for alternating-current application is limited in this case to the capacitor start-and-run type of motor. The capacitor motor, as it is more commonly known, has a capacitor permanently connected in series with one of its two windings. This acts to displace the current in one winding, thus producing a revolving field which provides the motor with an initial starting torque and drives the unit much like a two-phase motor. Motors of this type differ from the conventional split-phase and capacitor-start induction-run motors in that they require no centrifugal cutout switch and are therefore, preferred for installations where frequent starting and reversals are necessary. Capacitor motors are quiet in operation and have good efficiency. Unfortunately, standard capacitor motors have a rather low starting torque as compared with the split-phase motor—usually about 70 per cent of their full-load torque.

When fully loaded with index cards of equal size, the card wheel would be relatively well belanced. Under these conditions, the torque required to drive the wheel at the required speed of 10 rpm need be only that to overcome the friction of the bearings supporting the drum. Obviously, however, since the slightest degree of off-balance would introduce an additional torque component, the starting torque should not be measured under these conditions. The worst conceivable condition would be simulated by removing all of the cards on one-half of the wheel's periphery. Although it is rather unlikely that this condition would ever exist in actual operation, the torque measured under these circumstances would form an excellent basis for calculation of the maximum horsepower required. Where low voltage conditions are anticipated, an adequate safety factor should be employed in determining the motor rating.

Employs High-Resistance Rotor

Since the torque requirements at start are greater than the running torque under average load conditions, the standard capacitor motor would not be suitable for this application. In cases of this nature, higher starting torque can be obtained by incorporation of a special high-resistance rotor, or by strengthening the motor winding. With the special rotor, starting torque will be increased, but at the expense of efficiency, speed and running torque. Slip is increased somewhat, but this is advantageous in some cases, since operation of the motor is more quiet under these conditions. Use of a stronger winding (in the same motor frame) is permissible only when the duty cycle is such that the motor temperature will never execeed the allowable limit; at least for not more than short periods of time. Since reduction in motor speed and running torque is of no importance in this application, the special resistance rotor is employed to obtain the necessary starting torque.

Capacitor motors can be wound for either 3-wire reversible, or 4-wire reversible operation; either of which would be satisfactory from a performance standpoint. Reversal of the 3-wire motor can be accomplished with a simple single-pole double-throw switch. A double-pole double-throw switch is normally employed to reverse a 4-wire capacitor motor. In the interest of switching simplicity, the 3-wire reversible motor, *Fig.* 3, has been chosen for the application. Although switching problems can be simplified with use of this winding, motors wound for this service sometimes require capacitors of larger size than required for 4-wire motors. Where space limitation is a factor, this is sometimes a disadvantage.

Bronze gears are used in preference to plastic gears because of the effect of inertia during reversal operations. Except in very low ratios, worm gears have self-locking characteristics which would prevent them from absorbing some of the shock which would be transmitted to them when the load is suddenly locked or reversed. Because of their greater shear strength, bronze gears would be more capable of withstanding the strain placed on the individual gear teeth than would plastic gears of equal size. The self-locking feature of the worm gear is used to advantage as a means of holding the card wheel in place when the load is unbalanced.

Assets to a Bookcase

Heat Pumps

By Philip Sporn, president of the American Gas and Electric Service Corporation; E. R. Ambrose, air-conditioning engineer of the American Gas and Electric Service Corporation; Theodore Baumeister, consulting engineer of the American Gas and Electric Service Corporation and professor of mechanical engineering, Columbia University; published by John Wiley & Sons Inc., New York; 188 pages, 5½ by 8½ inches, clothbound; available through MACHINE DESIGN, *$3.75 postpaid.*

The heat pump has been erroneously confined by an association with year-round air conditioning. The heat pump is, in truth, a material embodiment of a thermodynamic principle which has many potential industrial and manufacturing operations beyond the limits of heating and ventilating.

This pioneer volume on heat pumps offers a clear technical treatment of the development of the heat pump. It discusses the progress made in adapting it not only to building heating and cooling service, but also to such industrial processes as the evaporation and purification of liquids, the drying of solids, and the simultaneous chilling and heating of process fuels. The subject is presented by successive consideration of the thermodynamic principles involved; equipment design, specification and selection; and maintenance, operating, economic and installation problems. There is not a detailed discussion of all the theory, performance, and design of the multitude of equipment and apparatus which make an efficient heat pump. The authors include only the aspects of performance and design of the parts which are essential in the assembly of a good installation.

The heat pump, with its possibility of increasing the potential energy in our fuel to perhaps twice its present value, is commanding a great interest. This book should serve to sharpen the intellectual tools of many and should kindle enthusiasm for and in the work on problems of heat pump research, development, and broader industrial application.

□ □ □

Kinematics of Machines

By Leon M. Sahag, professor of engineering drawing and design, Alabama Polytechnic Institute; published by the Ronald Press Co., New York; 249 pages, 6 by 9¼ inches, clothbound; available through MACHINE DESIGN, *$4.00 postpaid.*

Although admitting that an engineering course in kinematics primarily involves displacements, velocities and accelerations regardless of the types of machine mechanisms involved, the author of this book believes that the importance of kinematics is more clearly brought out if the study is carried out in conjunction with links or simple mechanisms. Theory, or explanation made only with line diagrams and with no reference to an actual mechanism, has little value for practical purposes. Therefore, the divisions of this book—including chapters on motion in machines, instant centers, acceleration in machines, cams, gears, and flexible links, deal with the study of motions relative to particular mechanisms. The graphic method of solution, rather than analytical, is presented as being more convenient and more readily grasped by the majority of readers.

□ □ □

Treatise on Powder Metallurgy

By Claus G. Goetzel, vice president and director of research of the Sintercast Corporation of America and adjunct professor of chemical engineering at New York University; published by Interscience Publishers Inc., New York; 778 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$15.00 postpaid.*

Metal technology and its large number of related fields experienced a modern renaissance at the turn of the century. The art of molding and firing metal was revived and refined by scientific study. The result was a production method for the manufacture of metallic or metal-like bodies of simple or complicated shapes without the use of orthodox metallurgy practices such as melting, casting, ingot solidification, metal working, and shaping by machine operation. The application of metal powders has been expanding in all branches of metal technology and, subsequently, huge amounts of theoretical, empirical, and technological materials have accumulated in journals and patent literature. To reduce the vastness of data into an organized reference, the author prepared this treatise consisting of three volumes, the first of which receives the attention of this review.

Volume I deals with the technology of powder metallurgy processes, including a brief description of the underlying principles and a historical review. The production, properties, and testing of powders, as well as their conditioning for powder metallurgy operations are discussed, and a survey of the currently available commercial grades is made. The subject of pressing of powders is given considerable space, and the coverage of both the theoretical and practical aspects is attempted. Pressing at elevated temperatures is intentionally treated before a discussion of sintering because the view has been taken that hot-pressing is merely a mechanism parallel to ordinary molding. To stimulate further development, a detailed description of the hot pressing apparatus and techniques used for experimental purposes has been included.

The process of sintering is covered at great length in a theoretical review. The practical aspects of the sintering operation are separated from the theoretical discourses in individual chapters on operations, furnaces, and atmospheres. The technological review constituting Volume I is concluded with the individual treatment of such phases as working, heat treating, and finishing. Much space is devoted to the highly important practical subject of finishing for the reason that little has been published pertaining to this phase.

This encyclopedic treatment of powder metallurgy presents to the novice, expert, development engineer, and inventor, twenty chapters of principles, history, theory, experiment, technology, properties, production, and application. Coverage is so complete that the volume is equally useful as an introductory text, a reference book, a source for new applications, and a stimulus to new developments and new processes.

□ □ □

Combustion Engines

By Arthur P. Fraas, associate in motors, Aeronautical Institute of Technology, Brazil; published by McGraw-Hill Book Co., New York; 428 pages, 6 by 9¼ inches, clothbound; available through MACHINE DESIGN, *$5.50 postpaid.*

Intended for the use of engineering college seniors and engineers in industry, this text develops fundamental principles of combustion engines from elementary theory and then ties in theory with practical engineering methods. Although developed chiefly from the author's material on aircraft power plants, a major portion of the book is devoted to automotive type engines because of their greater commercial importance. Wartime and postwar gas turbine developments have been included, as well as material on the more common piston type small engines, and locomotive, marine and stationary power plants. Combustion problems are simplified by a set of five charts giving products of combustion of octane and air, one each for five representative fuel-air ratios. Numerous other charts and tables useful in engine performance analysis, laboratory testing, or development work are also included.

□ □ □

Design of Industrial Exhaust Systems

By John L. Alden, assistant works manager of Western Electric's Kearny plant; published by The Industrial Press, 148 Lafayette St., New York 13, N. Y.; 252 pages, 5½ by 8¾ inches, clothbound; available through MACHINE DESIGN, *$3.50 postpaid.*

Designers and engineers primarily concerned with the construction or purchase of industrial exhaust systems, have found the obtaining of data pertinent to their particular problems difficult because of the wide scattering or the secretive handling of such information. To combat this dilemma, the author has compiled data, theoretical tempered with the practical, to cover every aspect of installation or design of an industrial exhaust system—from the hood to the fan.

This treatise discusses exhaust ventilation. It deals in length with the design of hoods for dust and fume removal; the theory relative to design is presented in concise and adequate form. Correct estimation of pipe resistances is vital to successful design and, accordingly, the author goes into detail in his discussion of the contributing factors. There is an attempt to discount the many fallacies of pipe design as pertaining to method and application of theory. Treatment of the fundamentals of structural details, system planning, low-pressure pneumatic conveying is such as to afford the reader with a good foundation in the theoretical as well as an assist in practical application. Lengthy discourses enable one to better grasp the proper method of selection of dust separators and centrifugal exhaust fans. Parallel between this second edition and the first book is evident, but several chapters and many lesser additions have been made to inform the designer and engineer of the advancements of the past decade. Growth of the electro-chemical processes for surface preparation and finishing of metals has warranted broader treatment of fume control. New importance of axial-flow fans lends itself to extended discourses.

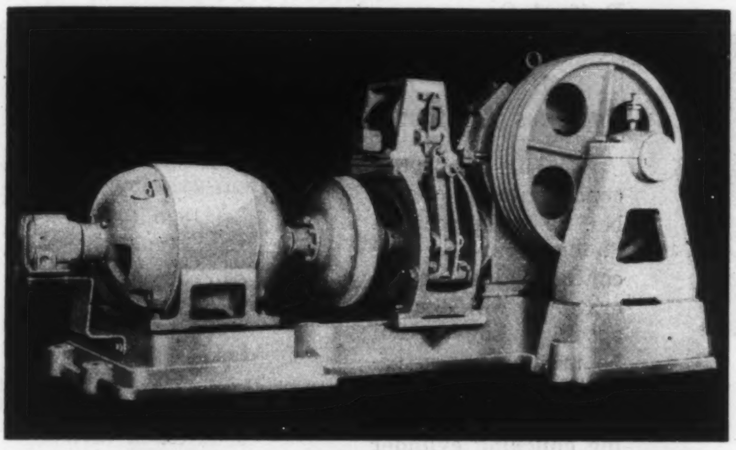
Replete with informative paragraphs, charts, diagrams, and tables this book tells how to design, build or buy an exhaust system that will adequately and economically perform the functions required by law or prescribed by specialists in industrial hygiene.

The book, *Wear as Applied to Cylinders and Piston Rings,* replete with charts, diagrams, tables, and informative discussions, is the result of an extended research project on this subject directed by Dr. F. P. Bundy now with General Electric's research laboratory. T. E. Eagan, chief metallurgist of Cooper-Bessemer, conducted the metallurgical studies; Ralph L. Boyer, vice president and chief engineer of Cooper-Bessemer, guided the application of the principles. Devoted primarily to reducing piston and cylinder wear, the investigation has revealed findings so basic in principle as to be of interest to all builders and large-scale users of engines, allied equipment and heavy machinery. Book may be secured from the Cooper-Bessemer Corporation, Mt. Vernon, Ohio, for $3.50.

Sanctioned by the SAE War Engineering Board's Iron & Steel Technical Committee, L. A. Aldinger has compiled the results of an investigation to determine the effect of variations in as-quenched hardness on tensile, endurance, and impact properties after tempering several steels. The 42-page report, *Physical Properties Influenced by As-Quenched Hardness,* is available from the SAE Publications Dept., 29 West 39th Street, New York 18, for $2.00.

Applications

of engineering parts, materials and processes

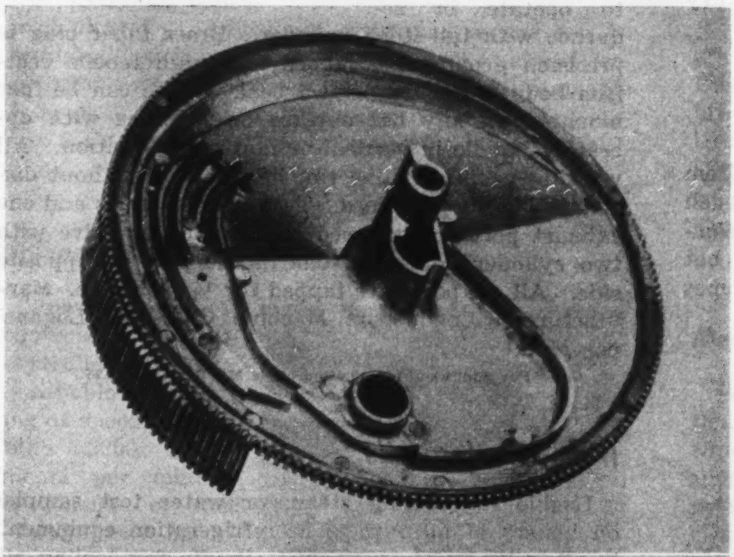


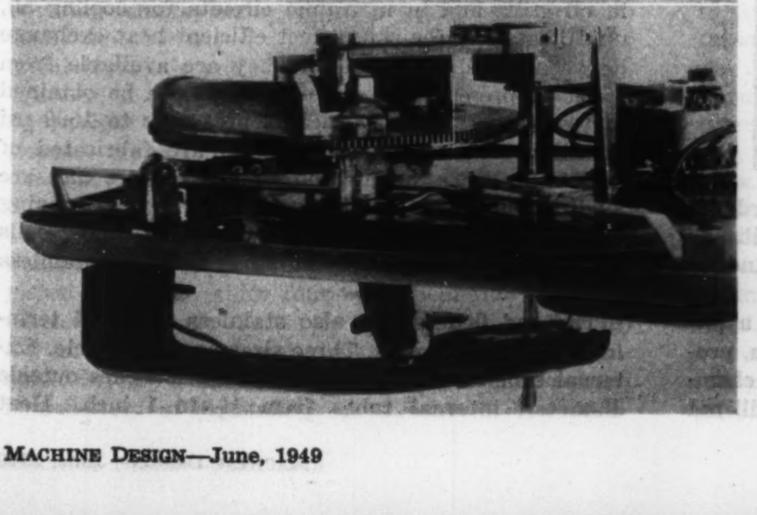
Obviates Complex Controls

CONTROL of the elevator-drive mechanism, left, has been greatly simplified by the use of a Gyrol fluid coupling. Previously, complex electrical controls were required to smoothly accelerate and decelerate the cars. Coupling obviates all but a single accelerating switch for each direction of travel, providing smooth motion and reducing the motor capacity required.

Cam Is Die Cast

RECORD-CHANGER cam of the General Instrument corporation's automatic record changer, left below, is produced by die casting. Intricate surfaces are thus held to close tolerances without the necessity of further machining.





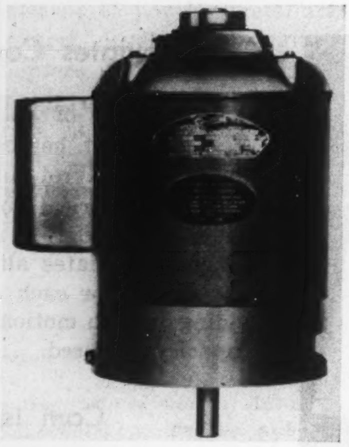
Protects Precision Mechanism

ABRASIVE-DUST damage to the delicate parts of the Hoglund contour wheel dresser, below, is prevented by the use of U. S. Rubber company's flexible corrugated tubes. Fitted over the template slide and piston rod mechanism, the tubes prolong the life and maintain the accuracy of the dresser without in any way impeding motion.

new parts and materials

For additional information on these new developments see Page 175

Single-Phase Jet Pump Motors



Line of new motors designed for automatic starting and stopping have starting torque and speed characteristics especially suited to jet pump service. Capacitor-start, single-phase type, these motors are built to NEMA standards of performance and dimensions. Three-phase and d-c motors have identical mounting dimensions making them interchangeable. Manufacturer: Century Electric Co., 1806 Pine St., St. Louis, Mo.

For additional information circle MD 1 on Page 175

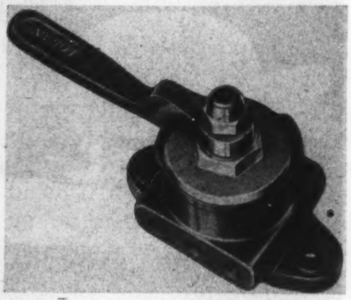
Punched Rubber Products

Capable of withstanding temperatures ranging from −150 to 500 F, punched silicone rubber products such as gaskets, washers, seals and packings are recommended for use in processing systems handling hot or cold fluids or gases and wherever rubber comes into contact with extreme temperatures. Standard and unusual flat shapes punched from sheets of silicone rubber can be made to exacting specifications and location of bolt holes held to practical accuracy.

Silicone rubber is also suitable for dielectric applications. It is resistant to permanent compression, prolonged weathering, lubricating oils and some chemicals, and has excellent water repellency. It will not become brittle or hard and will not crack after long exposure to air, ultra-violet rays or ozone. Manufacturer: Stalwart Rubber Co., 180 Northfield Rd., Bedford, O.

For additional information circle MD 2 on Page 175

Packless Air Control Valve



Of packless plug construction, model No. 50 three-position double four-way air control valve for operating two double-acting cylinders can be used on many sequencing applications, such as those requiring chucking cylinder to operate in sequence with tail-stock cylinder. Brass taper plug is precision ground and lapped into high tensile cast-iron body to assure perfect seal. Valve can be foot mounted on any flat surface on machine with operating handle in vertical or horizontal position. All working parts of valve can be removed without disconnecting air pipe lines. Two cylinder ports and one exhaust port are grouped on one side of valve with two cylinder ports and one intake port on opposite side. All six ports are tapped for ¼-inch pipe. Manufacturer: Logansport Machine Co., Inc., Logansport, Ind.

For additional information circle MD 3 on Page 175

Heat Transfer Coils

Usable for cooling steam or water test samples on boilers of all ratings in refrigeration equipment, in oil stills and in hydraulic circuits for cooling oil, dual heat transfer coils effect efficient heat exchange between liquids and gases. They are available from stock as pre-engineered units. Coils can be obtained in two ratings. For service at pressures to 1000 psi and temperatures to 700 F, units are fabricated of seamless copper tubing and bronze fittings and are available in six standard sizes. For pressures ranging to 2000 psi and temperatures to 1500 F, outer coils are of seamless copper, while inner coils are stainless steel.

The end fittings are also stainless, and coil terminals are carbon steel. Three sizes are obtainable. External tube size ranges from ½ to 1½ inches outside diameter, internal tubes from ¼ to 1 inch. Heat transfer area ratios range from 2.62 sq ft external coil and 1.41 sq ft internal coil to 7.85 sq ft external and 5.81 sq ft internal. Triple-lok fittings meeting J.I.C. hydraulic standards are used on all coils. Drilled mounting brackets are furnished. Manufacturer: Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, O.

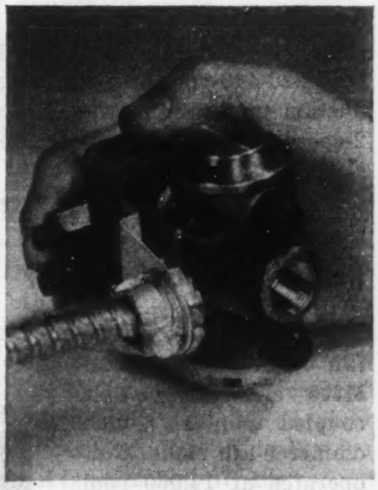
For additional information circle MD 4 on Page 175

Rate and Position Gyroscopes

Telemetering rate gyros calibrated for rotational measurements from 10 to 1000 degrees per second, and position gyros with one and two-axis electrical sensory elements are now available. Accuracies are better than ± 2 per cent. Production gyros have been standardized with 2000, 2500, and 5000-ohm resistance pick-offs. Additional resistance ranges can be furnished on request. Rate gyros offer natural frequencies to 40 cycles per second and are obtainable damped or undamped. Manufacturer: G. M. Giannini & Co., Inc., 254 West Colorado, Pasadena 1, Calif.

For additional information circle MD 5 on Page 175

Solenoid Air Control Valve



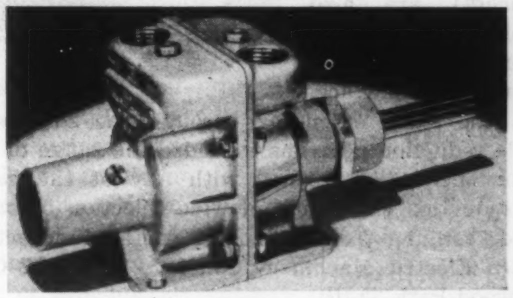
Powered by air it controls, solenoid-controlled air valve is capable of operating at speed of more than 2200 movements per minute. It consists of cast bronze body incorporating single air inlet, suitable electrical terminals and cylinder in which lightweight piston floats. Operating through $^{1}/_{32}$-inch of movement, plungers of small 8-volt solenoids release full pressure of air supply line to drive piston and thus shift four-way shear-flow valve in desired direction. Valve operates on 5 to 150 psi air line pressure. Despite high rate of speed, solenoids develop very little heat, and this is dissipated immediately in expanding air stream.

Valve is compact and completely enclosed. It will operate submerged, and presence of water or oil in air line does not affect operation. Available in ¼ and ⅜-inch port sizes, valve is adaptable to direct connection or remote control of any standard air cylinder. Manufacturer: Bellows Co., 222 W. Market St., Akron 10, O.

For additional information circle MD 6 on Page 175

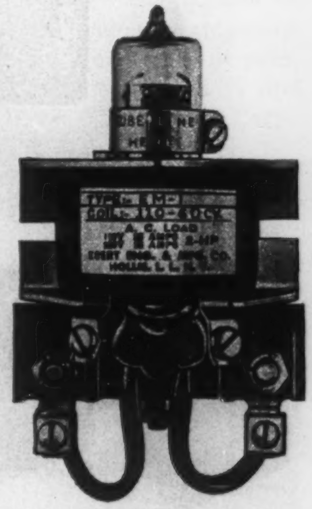
Gearless Hydraulic Pump

Small Eco gearless hydraulic pumps are available in ¼, ⅜, ½ and ¾-inch sizes having capacities ranging from 1 to 12 gallons per minute. Units are suitable for handling wide range of liquids and viscous fluids against pressures ranging up to 100 psi. They are designed to run at speeds from 200 to 2400 rpm. Dual eccentric piston provides strong flow against pressure. Pump body is naval bronze forging or stainless steel casting and is built to withstand hard usage. Fitted with self-lubricating bearings, pumps will not contaminate liquids handled. Manufacturer: Eco Engineering Co., 12 New York Ave., Newark 1, N. J.



For additional information circle MD 7 on Page 175

Mercury Relay



Incorporating free-floating magnetic plunger which assures smooth, silent operation, this improved mercury relay carries current loads of up to 35 amp. Design features permit reduction in size of heavy glass enclosure and assure flickerproof performance in sign flashing applications. Heavy tungsten contacts with mercury-to-mercury make and break are hermetically sealed against dust and moisture. There is no exposed arc, and relay is safe to use under all operating conditions. Coil and load terminals are accessible on all installations. Relays can be furnished in two and three-pole units. They are listed by Underwriters' Laboratories. Manufacturer: Ebert Engineering & Mfg. Co., 185-09 Jamaica Ave., Hollis, Long Island, N. Y.

For additional information circle MD 8 on Page 175

Totally Enclosed Motors and Gearmotors

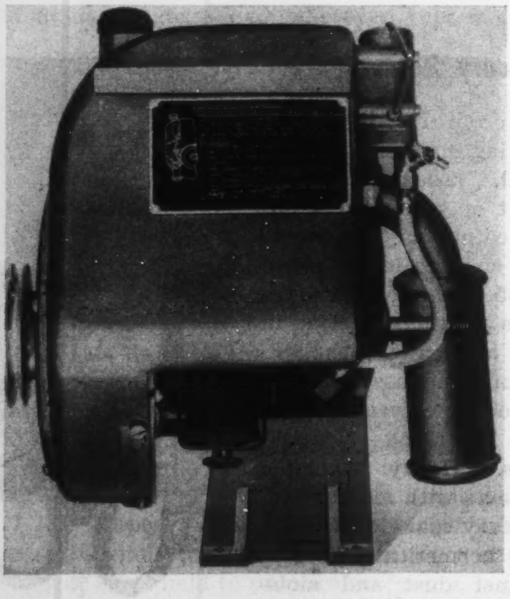
UNITED
FAN COOLED

Fan-cooled, totally enclosed motors particularly adaptable for dirty, dusty and corrosive atmospheres are being offered with standard or stainless steel shafts. Footless motors (without reducers) are also furnished for flange mounting to the face of any flat surface, with the shaft extending through the surface. A single reduction gear has extended the range of gearmotor speeds. Combined with any of the motors, the reduction can supply a wide selection of out-put speeds ranging from 6 to 3600 rpm. Manufacturer: United Electric Machinery Co., 1824 North 72 Court, Elmwood Park 35, Ill.

For additional information circle MD 9 on Page 175

Portable Gasoline Engine

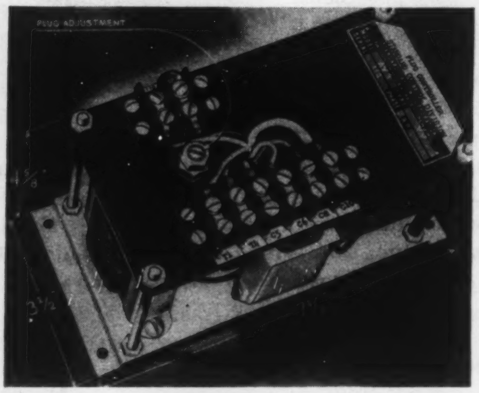
Weighing only 30 pounds, 2-cycle gasoline engine is especially suitable for use on saws, generators, tractors, fire fighting pumps, compressors, conveyors and other portable units. It develops 4-hp at 4500 rpm and has 2-inch bore and 2-inch stroke. Die-cast aluminum parts afford both durability and lightness in weight. Regardless of position in which engine is operating, diaphragm carburetor assures steady supply of fuel. Passage in crankcase and front cover, which permits unburned fuel to return to carburetor, eliminates flooding or overloading engine. Anti-friction bearings protect rotating parts from wear and thus insure long life, smooth operation and easy starting. Manufacturer: Prentice Corp., Dept. E-7, Worcester 4, Mass.



For additional information circle MD 10 on Page 175

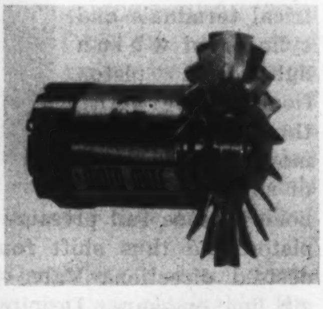
Electric Plug Controller

Requiring no mechanical connection to the motor, all-electric plugging control employs stator ripple voltage as its basis of operation. Although particularly adaptable where resistance plugging is used to reduce the shock during the plug cycle, the controller is suitable for use on drill presses, lathes and applications where gearing introduces friction between the motor and the final drive. Designed for panel mounting and easy installation, the controller also features long life, accurate control, potentiometer adjustment for desired drop-out speed, and plugging in both directions of rotation. Available in three sizes for use with 220-440-volt, 60-cycle, 3-phase, Y-Y connected induction motors, and with 220-volt, 3-phase, 60-cycle, 2-speed motors. Manufacturer: Standard Dayton Corp., Dayton 1, Ohio.



For additional information circle MD 11 on Page 175

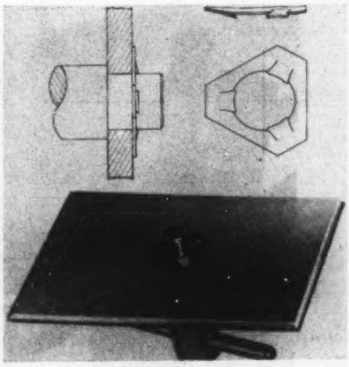
Reversible Electric Blower



Type MF-1 electric fan consists of a Moto-Mite electric motor coupled to a $2\,^3/_{16}$-inch diameter fan blade. Unit operates at 14,000 rpm and will move air at 35 cubic feet per minute. Power requirements are 19 watts at 6, 12 or 24 volts d-c. Fan is reversible, so that air can be blown either over or away from motor frame. Overall length is 2¼ inches and motor diameter is $1\frac{3}{16}$ inches. Weight is 6 oz. Manufacturer: Globe Industries Inc., 125 Sunrise Place, Dayton 7, O.

For additional information circle MD 12 on Page 175

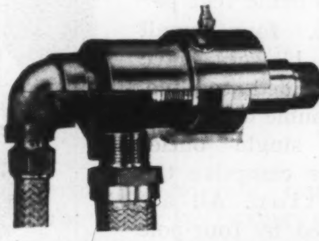
Self-Locking Retainer



Tight assemblies free from end play are developed on relatively soft shafts of cold-rolled steel, castings and plastics by this type 5305 Truarc triangular retainer which is installed or removed without using special tools. It is made with flat or spherical cross-section and has three equally spaced projecting prongs. When slipped over shaft, it can be positioned quickly and easily in direction of installation. Three prongs lock securely around shaft when slightest pressure is applied from opposite direction. Retainers are available in sizes for shaft diameters ranging from 0.090 to 0.375-inch, and other sizes are being added to line. Manufacturer: Waldes Kohinoor Inc.. 47-16 Austel Place, Long Island City 1, N. Y.

For additional information circle MD 13 on Page 175

Rotary Union Connection



Incorporation of heavy Monel metal bellows in all-purpose ball-bearing rotary union connection eliminates need for spring loading, provides self-adjusting pressure on extra heavy service and minimizes friction drag. It is designed for introducing steam or coolants into rotary drums such as are used on paper machines, dryers, calenders, printing presses, rubber-making cylinders and other equipment in process industries. Flexible rubber or bronze hose eliminates need for complicated piping and supports and permits connection to float, thereby avoiding unnecessary strain on sealing surfaces. Unit is available in plain and syphon types. Manufacturer: Perfecting Service Co., 6140 Cottage Grove Ave., Chicago 37, Ill.

For additional information circle MD 14 on Page 175

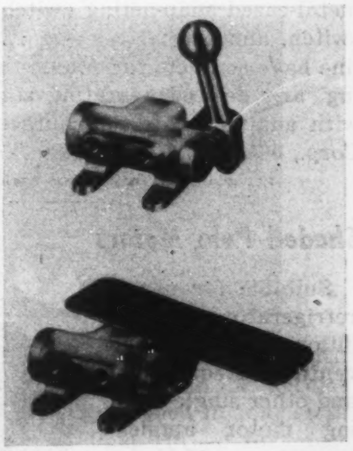
Corrosion-Resistant Plastic Paint

Metal, wood and ceramic surfaces are protected against chemical attack by corrosive fumes, condensates and spillage when series NPC CycLon, high-solid synthetic paints are applied. Plastic coatings air-dry quickly by solvent evaporation to adhesive hard-wearing glossy surfaces without need for first priming surface to be coated. When applied by brush directly from container, compound will give coverage of from 350 to 450 sq ft per gallon per coat.

Coatings are unaffected by all alkalies and most mineral acids and are inert to alcohols, soaps, water, oxidants, food and fruit acids, oils and aliphatic hydrocarbons. Moisture vapor transmission rate of film is less than 2 grams per 100 square inches of area for 24 hours at 100 per cent relative humidity. Coatings maintain flexibility at temperatures up to 180 F. Available through Munray Products Inc., 12400 Crossburn Ave., Cleveland 11, O.

For additional information circle MD 15 on Page 175

Foot-Operated Control Valves



Designed for control of single and double acting cylinders in pneumatic or fluid circuits, CV control valve series has been increased by addition of cam operated model and foot controlled valve with spring return action. Foot operated valve permits close-to-floor operation to make possible applications not practical with previous models. Identical housing assembly for all models in same pipe size permits hand, foot, cam, electrical or pressure pilot operation and, in most instances, conversion from one to other without breaking line connections or dismounting valve. Automatic and semiautomatic sequences can be secured with either spring or pressure pilot actuation. Valves are available in $\frac{3}{8}$ and $\frac{3}{4}$ 18-port sizes. Manufacturer: Modernair Corp., 4222 Hollis St., Oakland 8, Calif.

For additional information circle MD 16 on Page 175

Rolled-Thread Inserts

Usable in molded plastic, rubber and other products, low cost deep-drawn rolled-thread inserts are made of light gage steel on automatic machinery. They are available in 6-32, 8-32, 10-32 and $\frac{1}{4}$-20, thread sizes. Inserts offer good anchorage characteristics. Because of thin wall sections, they can be located close to edges or corners of molded parts without risk of cracking parts. Manufacturer: Clover Industries, Inc., 539 Ellicott St., Buffalo 3, N. Y.

For additional information circle MD 17 on Page 175

Adapter Plate for Switches

Consisting of ratchet-driven rotary detent cam which alternately presses and releases operating button of switch when drive plunger is pushed, style P Adaptaplate provides single - button maintained contact control with any Unimax metal-cased snap-acting switch. One stroke operates switch, and second releases it. Since all switches in line have contacts for double-throw single-pole switching, any desired operating sequence can be obtained with adapter plate. Manufacturer: Unimax Switch Corp., 460 W. 34th St., New York 1, N. Y.

For additional information circle MD 18 on Page 175

Shaded Pole Motors

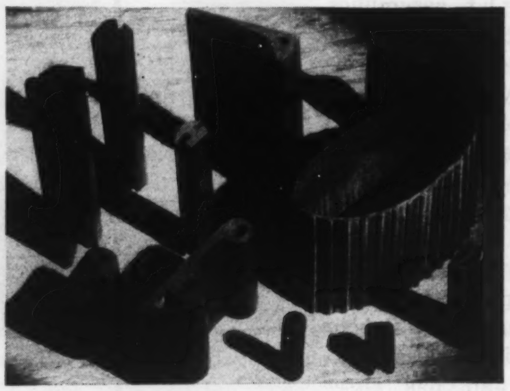
Suitable for use in refrigerators, air conditioners, heating and ventilating equipment and other single-bearing motor applications, type AM Mono-Motor is of four-pole shaded pole type. Features include large permanently-sealed oil reservoir isolated from heat, forced-feed lubrication of bearing surfaces by means of integral spiral pump on shaft, and recirculation system for lubricant. Long single bearing maintains shaft alignment and assures free-running rotor. Die-cast aluminum rotor is centered in field position by magnetic forces when operating so as to minimize end thrust. Fins on cast-iron case dissipate heat. Manufacturer: Redmond Co. Inc., Owosso, Mich.

For additional information circle MD 19 on Page 175

Synthetic Rubber

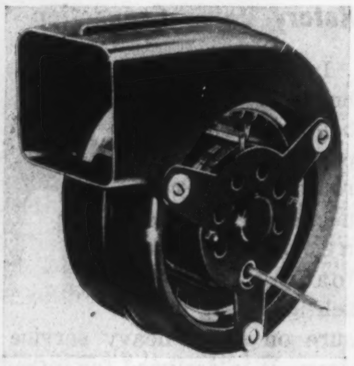
Developed for applications in which rubber must withstand very low temperatures for prolonged periods of time and yet retain its flexible qualities, this Butaprene-based rubber compound is unaffected by continuous temperatures as low as −50 F. It is recommended for use in refrigeration systems; aircraft, automotive and other transportation equipment; outdoor lighting units; farm implements; marine installations; and many others.

Compound looks and acts same as conventional rubber and has permanent set of 4 per cent, specific gravity of 1.25 and durometer hardness of 55. It is resistant to mineral, animal and vegetable fats; dilute acids; alkalies; petroleum products; hydrocarbons; and solvents. Butaprene-based rubber can be extruded into channels; lathe-cut or punched into gaskets, washers and grommets, and molded into almost any practical shape. Manufacturer: Stalwart Rubber Co., 180 Northfield Rd., Bedford, O.



For additional information circle MD 20 on Page 175

Small Blowers

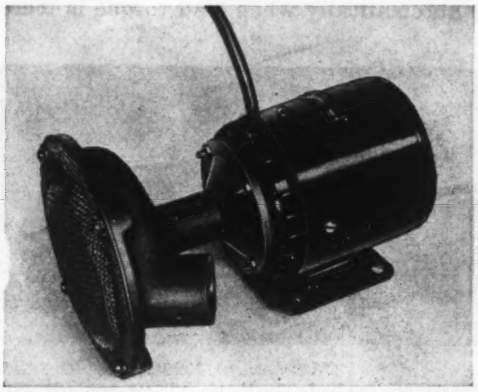


Designed for outputs varying from 80 to 220 cubic feet per minute, four small motor blowers have been added to line. One double outlet and three single outlet units comprise the addition. All are powered by four-pole Redmond motors except 80 cubic feet per minute output model which is powered by two-pole motor. Other features of these blowers include heavy gage steel construction, resiliently mounted motors, accurately balanced wheels and optional inlet screens and outlet flanges. Illustration shows model 3802 blower which has motor mounted inside of blower wheel making it very compact and neat appearing for applications where unit is exposed to view. This unit has output of 100 cubic feet per minute. Manufacturer: Redmond Co. Inc., Owosso, Mich.

For additional information circle MD 21 on Page 175

Centrifugal Water Pump

Intended for low-pressure flows, motor-driven centrifugal pump for water or other coolants has a capacity of 10 gallons per minute at 5-ft head. Its sturdy yet simple construction and oversize, totally enclosed, double ball-bearing, 1/25-hp motor contribute to long life. Made of noncorrosive materials, the pump is completely rustproof. Pumps are furnished for operation on 115 or 230 volt, 50 or 60 cycle a-c, and 115 or 230 volt d-c. Manufacturer: Thompson Products Inc., Cleveland 17, Ohio.



For additional information circle MD 22 on Page 175

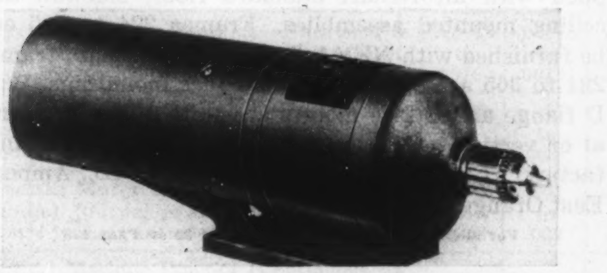
Hardfacing Alloys

Fifteen alloys are available in a new line of hardfacing welding metals. The alloys are divided into three groups: Ferrous, cobalt base and tungsten carbides. They are recommended for use in combating abrasion, impact, heat and corrosion. These alloys are said to increase equipment life up to 25 times. Manufacturer: Air Reduction Sales Co., 60 E. 42nd St.. New York 17.

For additional information circle MD 23 on Page 175

Drilling Unit

Drilling, tapping, centering, chamfering, counterboring, countersinking, tube facing or flaring, reaming, hollow milling, rivet spinning and other jobs can be handled by means of this Black power drilling unit. Because spindle and traversing motor rotor are integral, torque is applied evenly around spindle to eliminate end play. Air feed provides rapid, shockless advance to work, and hydraulic control from this point handles operation until work cycle is completed. Feed of drill is constant even when breaking through. Micrometer stop controls depth drilling accuracy to within 0.001-inch.



Drilling units from ¼ to 1 hp have same base-to-center-of-spindle dimensions. Speeds available are 840, 1150, 1725 and 3450 rpm for 208, 220, 440 and 550-volt, 3-phase 60-cycle current. Units will operate in any position. Manufacturer: Black Industries, 1400 E. 222nd St., Cleveland, O.

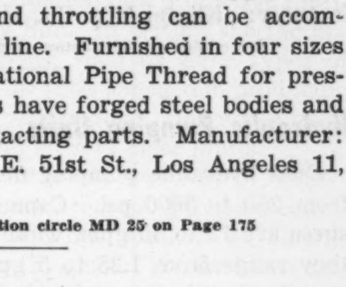
For additional information circle MD 24 on Page 175

Manual Control Valve

Manually actuated four-position dual-pressure valves are suitable for use on accumulator-actuated high and low pressure presses employing water or oil as service medium. Incorporating Shear-Seal design, valves provide fast operation. When moved through 90-degree arc, single lever permits separate introduction of low and high pressure fluid. Intermediate shut-off position permits all flow to be stopped with little handle motion, and throttling can be accomplished on low pressure line. Furnished in four sizes from ¾ to 2 inches National Pipe Thread for pressures to 7000 psi, valves have forged steel bodies and stainless steel fluid-contacting parts. Manufacturer: Saval Inc., Dept. 1915 E. 51st St., Los Angeles 11, Calif.

For additional information circle MD 25 on Page 175

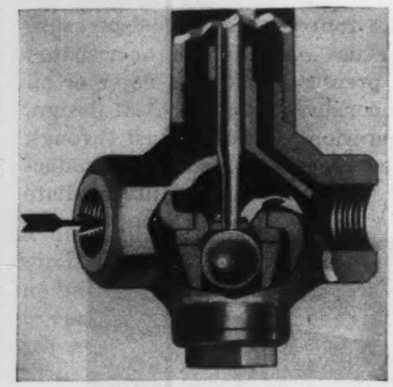
Magnetically Operated Relay



Magnetically operated bulletin 103 relays fulfill aircraft requirements and are also suitable for remote and automatic control purposes where conditions of vibration and shock are encountered. Relays withstand acceleration tests above 10 g and 60-cycle vibrations of 1/32-inch amplitude. Basic parts are mounted on molded phenolic base with front-connected post type terminal inserts. Contact gap, tail spring and normally closed contacts are adjustable. Standard single-pole double-throw d-c relays are rated as follows: normally open contacts, 25 amp, 24 volts d-c or 115 volts, 50 to 60-cycle a-c, normally closed contacts, 2 amp on d-c or 115 volts, 50 to 60-cycle a-c. Continuous duty coils are available for operation up to 115 volts d-c or 230 volts 60-cycle a-c. Manufacturer: Ward Leonard Electric Co., Mt. Vernon, N. Y.

For additional information circle MD 26 on Page 175

Ball Type Inner Valve



Usable for accurate regulation of steam, water, air or gas at inlet pressures less than 250 psi, at reduced pressures below 150 psi and where reduced pressure must be adjusted frequently, 400 series ball type inner valves are single seated with ball inner valve actuated by rubber diaphragm. Ball centers freely on seat with uniform contact all around which assures tight closing at moment it seats. When off seat, stainless steel ball is free to turn so that all parts are exposed in turn to scouring action of flow and any wear which may occur will be evenly distributed. Manufacturer: Klipfel Mfg. Co., Hamilton, O.

For additional information circle MD 27 on Page 175

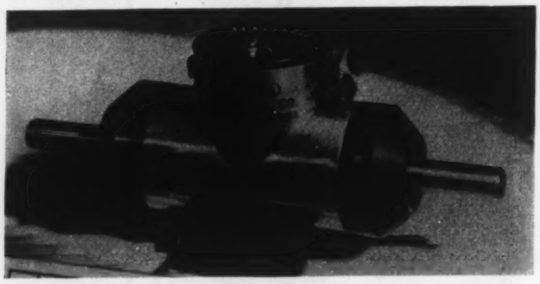
Hydraulic Pumping Units

Dual hydraulic pumping units are made in ratings from 250 to 5000 psi. Capacities at the lower pressures are 12 to 40 gpm, while at the higher pressures they range from 1.25 to 5 gpm. Units are reservoir mounted, with integral relief and unloading valves, double-end motors and oil cooler. Manufacturer: Universal Hydraulic Machinery Co., 285 Hudson St., New York 13.

For additional information circle MD 28 on Page 175

Miniature Speed Drive

Capable of delivering up to 70 ounce-inches torque and 0.025-horsepower, miniature adjustable-speed drive can be used on business machines, recorders, controllers, computers and similar devices. Ratio of input to output speeds is infinitely adjustable between 1:6 increase and 6:1 decrease with total speed range of 36:1. Dial and pointer indicate ratio setting, and adjusting knob is equipped with friction drag to prevent ratio wander. Maximum output torque is obtainable at zero speed, and operating speeds as high as 20,000 rpm are practical. Internal construction employs rollers which contact disks on input and output shafts. Speed is adjusted by changing radius at which rollers make contact. Lock-up devices are provided to increase contact pressure automatically when load torque is increased.

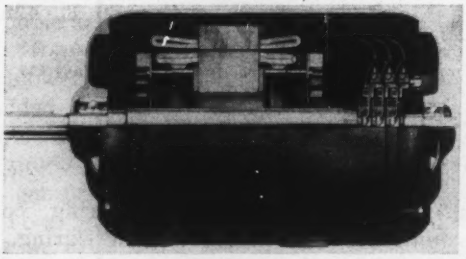


Other features include ball bearings on all rotating parts, permanent lubrication, overload protection and sealed construction. Manufacturer: Metron Instrument Co., 436 Lincoln St., Denver 9, Colo.

For additional information circle MD 29 on Page 175

Wound-Rotor Motors

This new protected type wound-rotor motor is available in NEMA frames 224 to 505 from 1 to 100 hp and in frames above NEMA, up to 2000 hp. Frames and end shields are drip-proof, and there are no unprotected openings above the horizontal center line. Also available in splash-proof and totally-enclosed nonventilated models, the motors can be supplied with all NEMA standard floor, sidewall and ceiling mounted assemblies. Frames 224 to 505 can be furnished with NEMA D flange mountings; frames 224 to 365 are available with C face mountings. Both D flange and C face motors are suitable for horizontal or vertical operation, with or without feet. Manufacturer: Crocker-Wheeler Electric Mfg. Co., Ampere, East Orange, N. J.



For additional information circle MD 30 on Page 175

Water Injection Pumps

New series RD-8500 fully-submerged, water-injection pumps for aircraft antiinjection employ viscosity-controlled fluid by-pass to prevent the compression of air in the fuel system when the pump is operated on an empty tank. Antifriction materials in the positive-displacement pump permit harmless dry-run-

JOHNSON BRONZE

SLEEVE BEARING DATA

Bearing DESIGN

Clearances

INTERNAL COMBUSTION ENGINE BEARINGS

Dia. of Crankshaft Journal or Crankpin	*Oil Clearance between shaft and bearing on diameter*	*Crankshaft End Clearance*
2" to 2¾"	.0015 ± .001	.004 to .006
2 13/16" to 3½"	.0025	.006 to .008
3 9/16" to 3¾"	.003	.008 to .010
3⅞"	.0035	.008 to .010
4"	.004	.008 to .010

*This data computed on the use of white or babbitt metals.

OIL CLEARANCE in sleeve-type bearings is that difference in size between the diameter of the shaft and the inside diameter of the bearing. This space accommodates the lubricant, permits the formation of a protective oil film preventing metal-to-metal contact when in operation and allows for expansion due to heat. Bearing performance, bearing life and machine operation are all greatly affected by oil clearances determined through correct dimensions of shaft and bearing.

It is quite impossible to set hard and fast rules for all applications. So many factors go into the successful operation of bearings that each should be given individual study and clearance data decided from the findings. However, certain general standards can be used as a guide towards correct oil clearances.

The above chart lists the average oil clearances most widely used for internal combustion engine applications. This applies to units in which a force feed, pressure lubrication system is used. The vertical clearance is generally maintained to low limits whereas higher clearance is maintained at split line, accomplished by eccentric bore or reliefs at parting line. For splash lubricated bearings, where the engine speed is less than 2000 R. P. M., the minimum oil clearance will be somewhat larger, varying from .0002 to .0006 per inch of shaft diameter.

BEARING CLEARANCES IN INDUSTRIAL APPLICATIONS

CLASS OF BEARING	*Running Clearance, Thousandths of an inch, for shaft dia. under*				
	½"	1"	2"	3½"	5½"
Precision Spindle Practice—Hardened & ground spindle lapped into the bronze bushing. Below 500 ft./Min. & 500#/Sq. In.	.00025 to .0075	.00075 to 0015.	.0015 to .0025	.0025 to .0035	.0035 to .005
Precision spindle practice—Hardened & Ground spindle lapped into bronze bushing. Above 500 ft./Min. & 500#/Sq. in.	.0005 to .001	.001 to .002	.002 to .003	.003 to .0045	.0045 to .0065
Electric Motor & Generator Practice—Ground Journal in broached or reamed bronze bushing or reamed Babbitt bushing	.0005 to .0015	.001 to .002	.0015 to .0035	.002 to .004	.003 to .006
General Machine Practice (Continuous rotating motion)—Turned steel or cold rolled steel Journals in bored & reamed bronze or poured & reamed babbitt bushings	.002 to .004	.0025 to .0045	.003 to .005	.004 to .007	.005 to .008
General Machine Practice (Oscillating Motion)—Journal & Bearing material as above	.0025 to .0045	.0025 to .0045	.003 to .005	.004 to .007	.005 to .008
Rough Machine Practice—Turned steel or cold-rolled steel Journals in Poured babbitt bearings	.003 to .006	.005 to .009	.008 to .012	.011 to .016	.014 to .020

Ordinary industrial applications can be governed by general clearance practice—as listed below. We have found, through more than 40 years exclusive bearing manufacturing experience, that the majority of applications can be so classified. The tolerance range, as shown by the chart, provides ample room for the formation of a protective lubricating film. In certain specific applications, such as some types of machine tools engaged in producing very precise parts, clearances must be held to very close limits.

There is one sure way of removing doubt concerning tolerances and oil clearances. Call in a Johnson Bronze Engineer. We are interested in giving you bearings that will suit your applications—bearings that will deliver greater performance and longer bearing life. Our men are trained in all phases of bearing practice. We offer their services to bearing users without obligation of any kind.

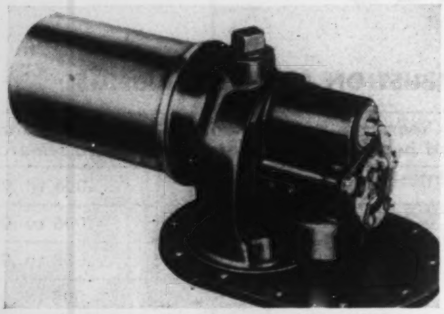
This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

SLEEVE BEARING HEADQUARTERS

525 S. MILL ST. • NEW CASTLE, PENNA.

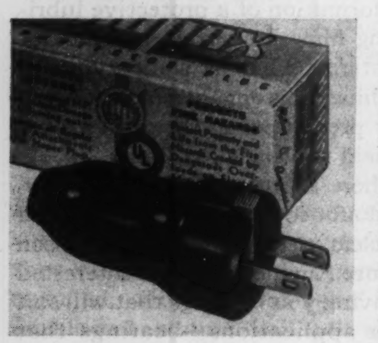
ning. Total submersion of the pump and motor unit within the water-alcohol tank simplifies installation and requires no external space for mounting. Electrical and fluid connections are located outside the mounting flange, under the tank. Galvanic action is eliminated by the use of nonconducting insulations between critical points, thus preventing water from acting as an electrolyte where dissimilar metals are present. Relief valve is adjustable to 50 psi outlet pressure with connection for supercharger compensation optional. Characteristics of a typical valve setting are: 210 gallons per hour at 34 psi outlet pressure, with maximum of 13 amp at 28 volts d-c. Fractional-horsepower, 400-cycle, 208-volt, a-c motors are included in the series. Manufacturer: Lear Inc., Romec Pump Co. Division, Elyria, O.



Circuit Breaker Plug, B-1, 1448

For additional information circle MD 31 on Page 175

Circuit Breaker Plug



Affording protection from overloading, stalling or rotor locking on any machine powered by fractional horsepower motor, Hopax circuit breaker plug is available in range of ratings up to 10 amp. Plug rated for capacity of equipment it serves should be used. Special types for applications requiring high current load for specified time can be furnished. Thus, it operates only when conditions become dangerous for particular appliance on which it is installed. Resetting is accomplished by removing plug from receptacle and raising and lowering lever beween prongs. Manufacturer: Hopax Electric Inc., 547 Greenwich St., New York 13, N. Y.

For additional information circle MD 32 on Page 175

Decorative Finish

Two-tone hammer finish known as Dimenso, is now available in a lacquer form. New finish, tradenamed Lacquer Dimenso has been developed for applications where baking is not practicable; it is applied by spraying and air dries in 20 minutes. The material is suitable for use on virtually all surfaces not subject to high-temperature service. Manufacturer: Sherwin-Williams Co., 101 Prospect Ave., Cleveland.

For additional information circle MD 33 on Page 175

Oil Pilot Valves

Obtainable in four standard mountings including pipe line, foot and panel, series 7000 oil pilot valves can be used for remote-control oil-pressure-operated four-way hydraulic valves. Operational control is gained by fork lever design which, when actuated by moving part of device being powered, permits remote reversing of main valve. Both fork lever and fork and hand lever types can be supplied; latter permits manual interruption of cylinder's forward or return stroke at any time. Valves can be supplied with all ports blocked in neutral, all ports open to exhaust in neutral, and cylinder ports open to exhaust and pressure port blocked in neutral. Manufacturer: Gerotor May Corp., Baltimore 3, Md.

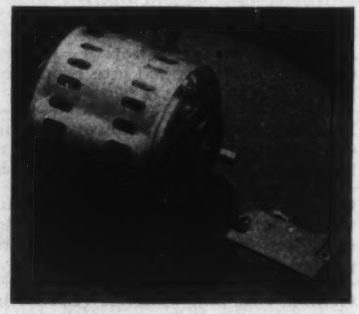
For additional information circle MD 34 on Page 175

Electrical Insulators

Bulletin 143 electrical insulators, formerly made of unglazed ceramic, are now made of glazed AlSiMag 228. Modification has been made to suit high frequency apparatus which requires insulators having an improved loss factor. Manufacturer: American Lava Corp., Chattanooga 5, Tenn.

For additional information circle MD 35 on Page 175

Business Machine Motor



Designed for use in typewriters, accounting machines and other business machines, type KH lightweight constant speed fractional-horsepower motors are of open ventilated sleeve-bearing construction. They can be obtained in ratings of: 1/40-hp, 1725/1425 rpm on 115-volt 60/50-cycle current; 1/40-hp, 1425 rpm on 115-volt 25-cycle current; and 1/20-hp, 3450/2875 rpm on 115-volt 60/50-cycle cur-

Genuine ALEMITE

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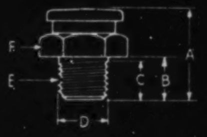
Button Head and Flush Type Fittings

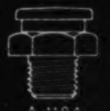
DATA SHEET

NO. 2

Useful Information to Help You Select and Specify the Right Alemite Fitting for Every Bearing

Simplify ORDERING, INSPECTION and INVENTORY CONTROL. Specify Alemite part numbers on your blueprints.





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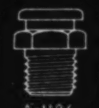

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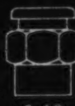
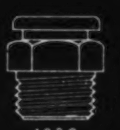


C-69



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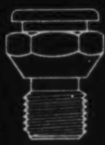
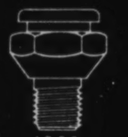


1822-A



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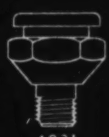

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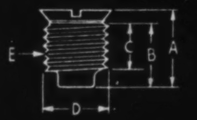

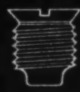

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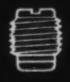

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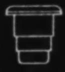
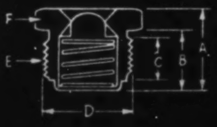
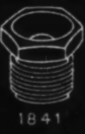


Z-730-A





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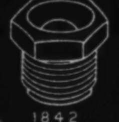

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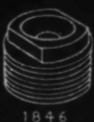


1846

STANDARD BUTTON HEAD FITTINGS

Part No.	DIMENSIONS					
	A	B	C	D	E	F*
C-69	29/32"	13/32"	9/32"	39/64"	1/8" P.T. Female	5/8"
A-1184	3/4"	11/32"	19/64"	13/32"	1/8" P.T.	5/8"
A-1186	53/64"	27/64"	3/8"	35/64"	1/4" P.T.	5/8"
A-1188	61/64"	31/64"	27/64"	43/64"	3/8" P.T.	3/4"
A-1190	1 5/64"	35/64"	31/64"	27/32"	1/2" P.T.	7/8"
1396	1"	1/2"	13/32"	43/64"	3/8" P.T.	3/4"
1401	53/64"	27/64"	3/8"	35/64"	1/4" P.T.	5/8"

*Wrench Size.

GIANT BUTTON HEAD FITTINGS

Part No.	DIMENSIONS					
	A	B	C	D	E	F*
1820	1 1/16"	1/2"	13/32"	27/32"	1/2" P.T.	7/8"
1821	1 5/16"	9/16"	7/16"	5/8"	5/8"-18 Thd.	7/8"
1822-A	1 5/16"	9/16"	29/64"	43/64"	3/8" Spec. P.T.	7/8"
1823	1 1/4"	1/2"	3/8"	35/64"	1/4" P.T.	7/8"
1825	2"	41/64"	11/32"	43/64"	3/8" P.T.	7/8"
1831	1 5/32"	3/8"	9/32"	13/32"	1/8" P.T.	7/8"
**1871-A	1 5/16"	9/16"	29/64"	43/64"	3/8" P.T.	7/8"
**1872-A	1 1/4"	1/2"	3/8"	35/64"	1/4" P.T.	7/8"

*Wrench Size. **1871-A and 1872-A have special construction to withstand extremely high pressures. Recommended for use on lubricated valves.

FLUSH TYPE FITTINGS

Model No.	A	B	C	D	E
†Z-730-A	7/16"	3/8"	....	5/16"	....
Z-741-A	9/16"	15/32"	7/16"	35/64"	1/4" P.T.
1452	1/2"	29/64"	29/64"	13/32"	1/8" P.T.
†1814	21/64"	9/32"	....	5/16"	....
1815	23/64"	9/32"	9/32"	13/32"	1/8" P.T.
†1817	11/32"	19/64"	....	3/8"	....
†1853	11/32"	19/64"	....	1/4"	....

†Drive Fittings.

GIANT FLUSH TYPE FITTINGS

Model No.	A	B	C	D	E	F*
1840	49/64"	39/64"	31/64"	5/8"	5/8"-11 Thread	3/4"
1841	49/64"	39/64"	31/64"	43/64"	3/8" P.T.	3/4"
1842	55/64"	39/64"	1/2"	27/32"	1/2" P.T.	7/8"
1843	7/8"	39/64"	1/2"	1 3/64"	3/4" P.T.	1 1/8"
1844	7/8"	5/8"	31/64"	1 5/16"	1" P.T.	1 3/8"
**1846	49/64"	19/32"	19/32"	1 3/64"	3/4" P.T.	11/16"
**1847	55/64"	39/64"	1/2"	27/32"	1/2" P.T.	3/4"

*Wrench Size. **Flush Fit No Hex.

FREE—Reprints for engineers, draftsmen, and all plant men. You may obtain a complete set of these data sheets covering all Alemite Fittings. Simply write to Alemite, 1804 Diversey Parkway, Chicago 14, Illinois.

Another Product of
STEWART WARNER

ALEMITE

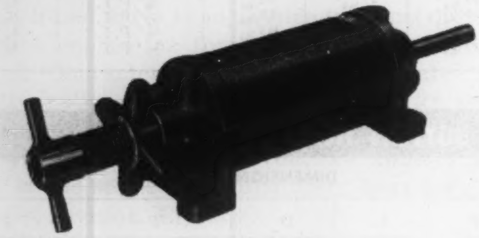
Modern Lubrication Methods That Cut Production Costs rent. All are equipped with double-bonded resilient mounting rings including latches and three 12-inch leads.

Centrifugal starting switches have been replaced by externally mounted switches which permit motor to be of smaller overall size and which include thermal cutout feature to open line circuit in time to prevent damage to motor in event of machine jamming. Manufacturer: General Electric Co., Schenectady 5, N. Y.

For additional information circle MD 36 on Page 175

Adjustable-Stroke Air Cylinder

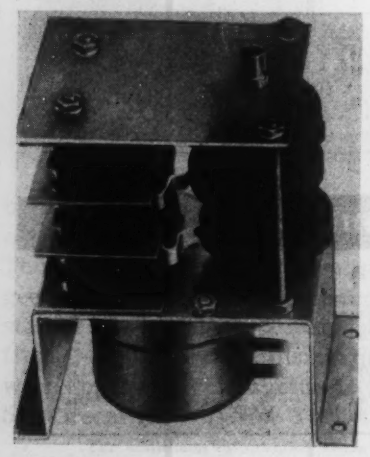
Adjusting screw with handwheel locking provides air cylinder with any desired length of stroke. A false piston, forming the movable blind end on the inside, is attached to the adjusting screw. Graphite packing enables the false piston to maintain an airtight seal, thereby limiting dead air space and helping to maintain efficiency at restricted stroke. Cylinder is available in any mounting except the clevis and the blind end flange, and is furnished in bores from 3 to 14 inches. Manufacturer: Anker-Holth Mfg. Co., 2723 Connors St., Port Huron, Mich.



For additional information circle MD 37 on Page 175

Four-Circuit Cycle Timer

Designed for built-in application, type CF3 single or multiple-contact cycle timer is used to regulate series of operations in equipment such as dishwashers and battery chargers and to operate motors, valves and signals. It will control automatically a one, two, three or four-circuit operation in predetermined timing sequence.

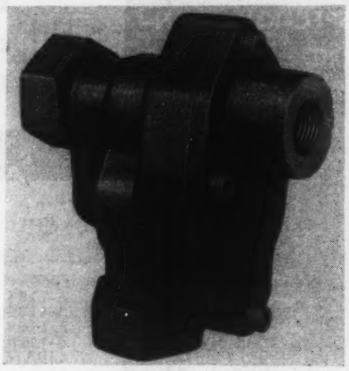


Unit consists of synchronous motor mounted on bracket. Single or multiple cams on shaft actuate enclosed dustproof snap-action switch. Wide range of motor speeds and 27 different ranges from 1 revolution in 10 seconds to 1 revolution in 24 hours permit unit to be used on almost any required cycle arrangement. Timer can be supplied with knob which permits manual starting, and it will complete one cycle and then stop. Manufacturer: R. W. Cramer Co., Centerbrook, Conn.

For additional information circle MD 38 on Page 175

Air Dumping Valve

Air cylinders can start their return in split second when this quick exhaust or dumping valve is used as supplement to standard operating valve. When latter is moved to open position and air starts to exhaust, dumping valve opens automatically so that cylinder starts its return almost immediately. Unit is mounted directly on cylinder and is available in pipe sizes from 3/8 to 1 inch. Manufacturer: Ross Operating Valve Co., 120 E. Golden Gate Ave., Detroit 3, Mich.

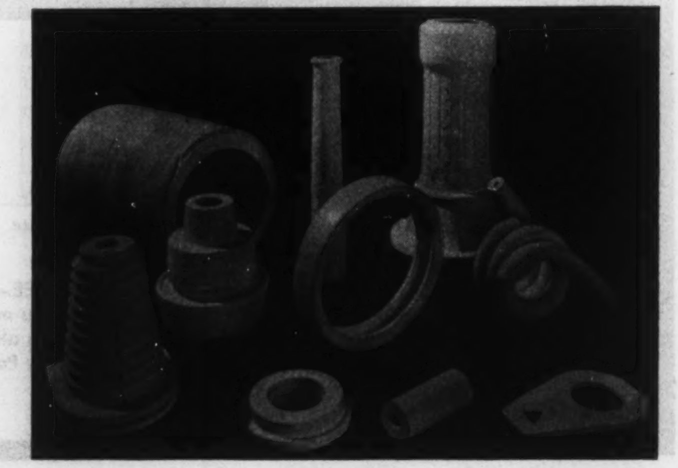


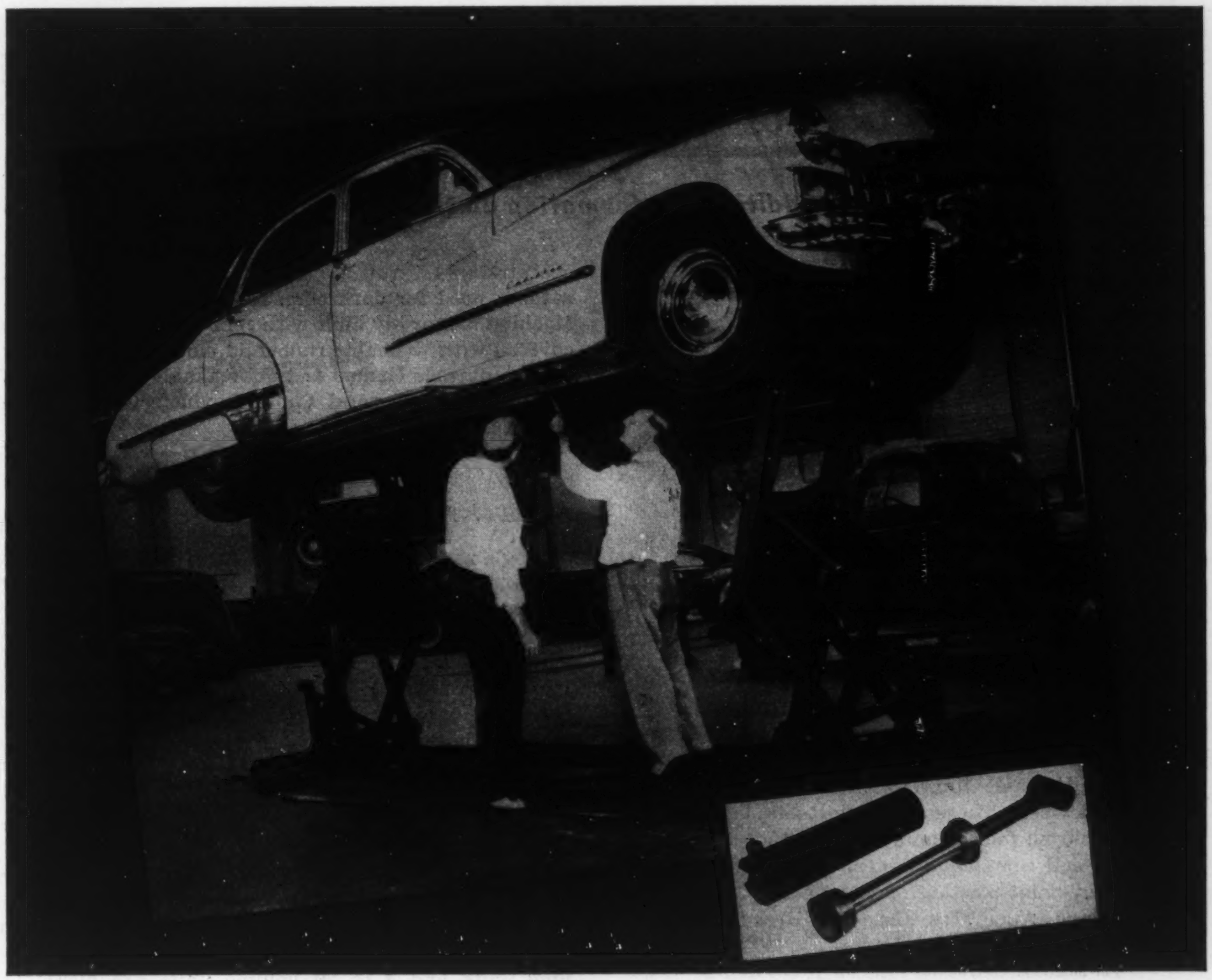
For additional information circle MD 39 on Page 175

Silicone Rubber Parts

Suitable for extremely low temperature application, X-6 silicone rubber gaskets, diaphragms, sleeves, packings, channels and numerous other molded, extruded, punched and die or lathe cut parts can be supplied to users' specifications. Brittle point of this material, measured on 1/8-inch thickness in accordance with ASTM D736-43T, ranges from −150 to −170 F. This synthetic rubber is resistant to action of sulphur dioxide, liquid ammonia and certain types of Freon as well as many chemicals and oils. Parts are suitable for high and low voltage applications, have high resistance to ozone and feature water repellency. Manufacturer: Stalwart Rubber Co., 151 Northfield Rd., Bedford, O.

For additional information circle MD 40 on Page 175





Weaver uses Houghton packings to give your car a "lift"

Service stations no longer have to excavate to install a lift for cars they lubricate. The new Weaver Twin Floor Lift is installed right on the garage floor at any convenient place, and will raise cars and light trucks hydraulically by the mere turn of a lever. The hydraulic cylinders are smaller and require less pressure than did the old style lifts, due to design change.

VIM Leather Cup Packings are used to hold the pressure. These packings, properly impregnated, moulded and trimmed to accurate size, can be depended on to maintain a tight seal against pressure loss.

Machine designers everywhere rely on VIM Leather and VIX-SYN Synthetic Rubber Packings because they know both the reliability of the products and the invaluable engineering service, freely provided. Have *you* a design problem? Put it up to E. F. HOUGHTON & CO., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

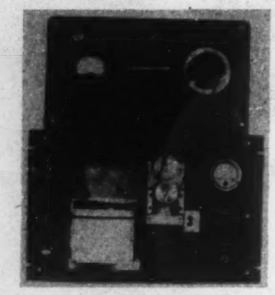
HOUGHTON'S

VIM LEATHER and VIX-SYN PACKINGS

engineering dept equipment

For additional information on this new equipment see Page 175

Recording Sound Analyzer

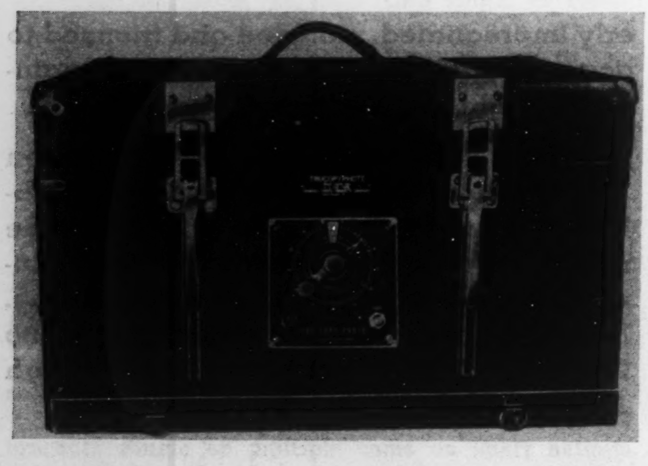


Frequency analysis of a complex wave form from 25 to 7500 cps is recorded on a 4-inch wide calibrated scale by the models FR and FR-1 recorders when used in conjunction with a General Radio 760-A sound analyzer. A permanent ink record is made on a frequency-calibrated longitudinal scale, the full scale width being calibrated linearly in equal 20, 40, 60 or 80 db divisions. A mechanical link unit is provided to automatically drive the frequency-sweep dial of the analyzer in register with the calibrated chart movement. The full frequency spectrum from 25 to 7500 cps or any specific range within this band can be recorded. Selection is provided by adjustable limit switches on the link unit coupling device. These fully portable instruments can be employed for the analysis and study of sounds, vibrations and complex voltages, effectively eliminating point-by-point plotting of these curves. Manufacturer: Sound Apparatus Co., 233 Broadway, New York 7.

For additional information circle MD 41 on Page 175

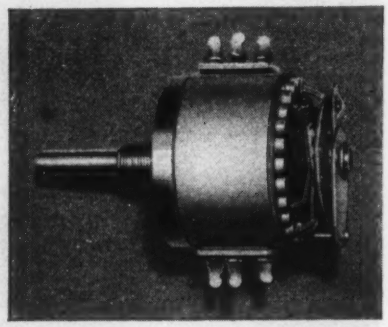
Photocopy Machine

Available in three sizes for handling 11 x 16, 14 x 20 and 18 x 29-inch standard cuts of paper, this Tru-Copy-Phote photocopying machine requires only 15 seconds to expose auto-positive paper. Machine is furnished complete with all necessary accessories including trays, dryer, paper, chemicals, color filter, red pilot light, squeegee board and glassware. It operates on 115-volt a-c or d-c in ordinary office light without need for darkroom, focusing or heating unit. Machine is sturdily built with reinforced plywood case covered with washable rubberoid cloth and has heavy hinges, durable clamps and unbreakable Tufflex glass. Manufacturer: General Photo Products Co., 15 Summit Ave., Chatham, N. J.



For additional information circle MD 42 on Page 175

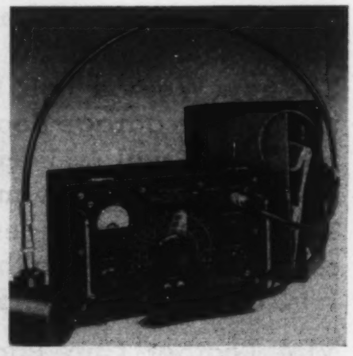
Attenuator



Single meter can be used with any number of lines to check volume units, with each line isolated from all others by using one or more of these V.U. meter multipliers. Measuring only 1¾ inches in diameter, device provides five-step straight-T performance. Pair of extra terminals permits off position to disconnect multiplier network from line which it normally bridges and from meter. Standard attenuation ranges of 0 to 16 volume units and 4 to 20 volume units are available. Both are provided in steps of 4 units and have "off" position. Manufacturer: Shallcross Mfg. Co., Collingdale, Pa.

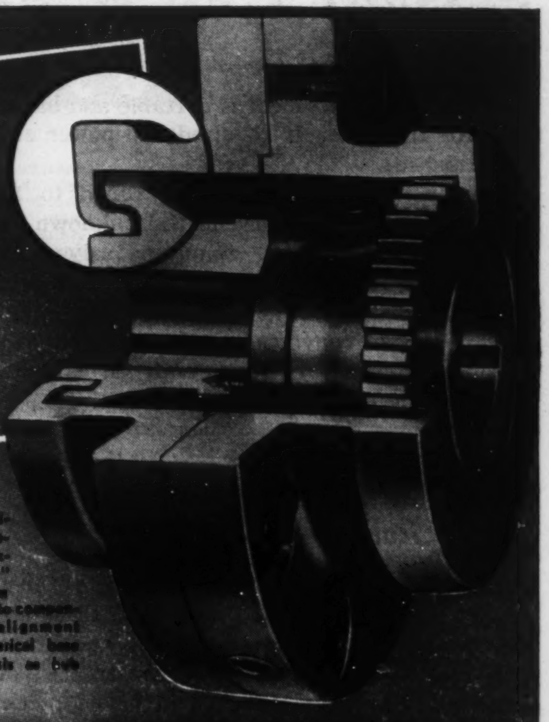
For additional information circle MD 43 on Page 175

Thickness Gage

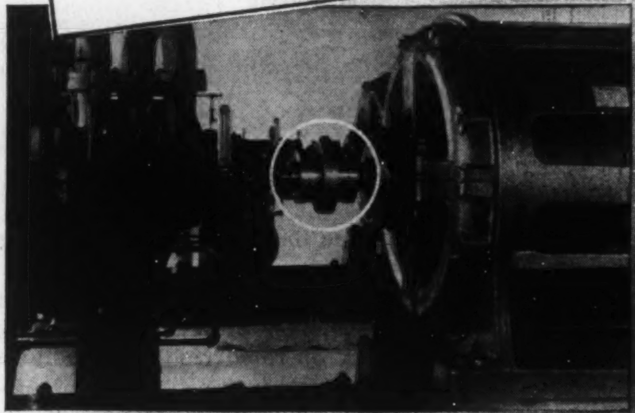


Improved model FMSS-5 Audigage thickness detector has been developed for nondestructive thickness measurement of steel, copper, aluminum, glass, unfilled plastics and other materials from one side. Typical applications include use on tanks, pipes, ship hulls, boilers, pressure vessels and sheet metal. Improvements include instrument indications which permit operation in noisy locations, adjustable frequency modulation which facilitates measurement of corroded equipment, permeability tuning unit for increased sensitivity, and increased frequency for measurement of steel down

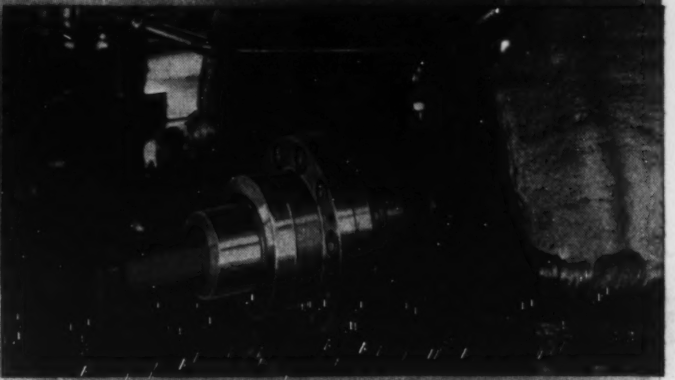
How Fast's Exclusive Metal to Metal Seal *Boosts* Your Plant's Production



Correctly engineered oil-protecting "rocking bearing" allows freedom of movement to compensate for misalignment because spherical base has same axis as hub spline faces!



OIL REFINERIES insist on Fast's Couplings to *keep* their vital machinery *running*, because they know Fast's virtually *eliminate* all shutdowns due to coupling failure! This Coupling has been in service since 1931.



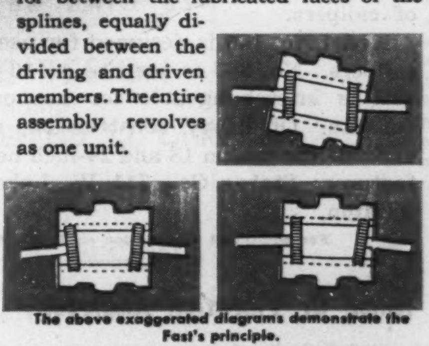
HEAVY INDUSTRIES specify Fast's Couplings because they compensate for shaft misalignment and have *no perishable parts* of any kind to fail!

YOUR production figures *go up* and *stay up* when your vital equipment is protected with Fast's Couplings, because Fast's virtually eliminate all shutdowns due to coupling failure. Fast's use no perishable parts or packing rings . . . they are the *original* gear-type coupling that *really* guards load-carrying oil from moisture, abrasive dust and grit! Fast's have *exclusive* "rocking bearing" principle that gives *sure* metal-to-metal seal.

When you specify Fast's you get years of top engineering experience, Koppers' high standard of workmanship, and unexcelled coupling service including available parts if required by change of drive, *even if your Fast's have been running for 30 years*. You save money, eliminate bottlenecks with Fast's on the job, because machine and motor life is prolonged, upkeep costs are cut, shutdown losses reduced. Find out about Fast's! Use the handy coupon, or write today for free catalog. Address: Koppers Co., Inc., Fast's Coupling Dept., 256 Scott Street, Baltimore 3, Maryland.

FAST'S COUPLINGS COMPENSATE FOR ALL MISALIGNMENT

The floating sleeve takes a neutral position. All forms of misalignment are compensated for between the lubricated faces of the splines, equally divided between the driving and driven members. The entire assembly revolves as one unit.



The above exaggerated diagrams demonstrate the Fast's principle.

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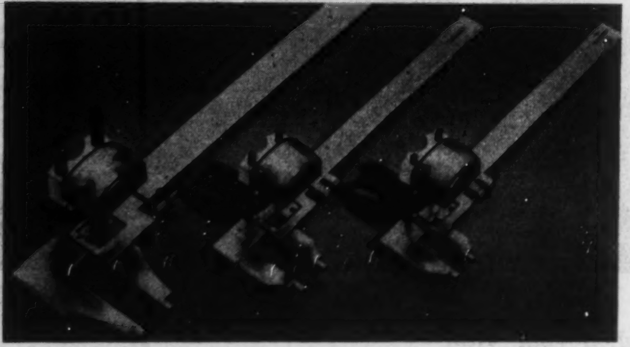
to 1/16-inch. Instrument is portable and battery operated for field use. If required, a-c power supply can be furnished.

For operation, instrument is tuned to frequency which produces resonance in the unknown thickness. Resonance is indicated simultaneously by milliammeter and head-phones to provide both visual and audible signals. Frequency at which resonance is indicated can be converted to thickness by use of conversion scale on instrument panel. Manufacturer: Branson Instruments Inc., Joe's Hill Rd., Danbury, Conn.

For additional information circle MD 44 on Page 175

Vernier Scale Magnifier

Intended to simplify reading of vernier scales, Magna Eye magnifier is available in three sizes to fit most widely used Brown & Sharpe and Starrett calipers and height gages. It is constructed of spring brass and aluminum finished in baked black enamel and is supplied in black leatherette case. Rectangular precision ground optical glass lens of 3½ to 4 power clips over head of reading scale and is held by two parallel posts for quick focusing. It is also movable horizontally to permit accurate reading on both sides of calipers.



Model No. 100 is designed for use on 6-inch vernier calipers. No. 200 is for use on 10-inch height gages and is interchangeable for use on 10-inch vernier calipers. Of heavy construction, model No. 300 is suitable for use on 18 and 24-inch height gages. Manufacturer: Stebar Co., 711 W. Lake St., Minneapolis 8, Minn.

For additional information circle MD 45 on Page 175

Noise Or Vibration Analyzer

Vibration detection and noise analysis in all types of equipment are performed readily with this Sono-Probe electronic amplifier. Long metal probe of microphone or Bakelite probe for electrical equipment testing is placed in contact with shaft, bearing, housing or other source of vibration. Because unit is insensitive to airborne sounds, operator can confine his investigation to object being touched by probe.

Earphones enable user to analyze character of vibrations; decibel meter and simple volume control permit accurate measurement of amount of vibration. Volume can be adjusted to acceptable standard decibel level, and vibration level of any number of parts or machines can be measured against it. Instrument provides go no-go or graded standard for inspecting parts or finished assemblies, for maintenance and trouble shooting, for diagnosing motor ailments, checking sound insulations and detecting air or water leaks.

Bench model operates on 115 volts d-c and is shown with probe in fixed position on standard bearing tester. Portable battery operated model is available for line testing of engines, pumps and large assemblies. Manufacturer: Aircraft Electronics Associates Inc., 1031 New Britain Ave., Hartford 10, Conn.

For additional information circle MD 46 on Page 175

Slow Speed Stroboscope

Extending stroboscopic method of analysis to low-speed mechanisms, Strobolume high-intensity short flash stroboscope is designed to be flashed from external contactor. This remote control feature makes it particularly useful where motion to be examined is related to angular position of shaft. Applications of this type include textile looms, printing presses, fuel injection systems and heavy machinery in general. Device will operate continuously at speeds up to 45 flashes per minute; operation for shorter periods is possible up to 1200 flashes per minute. When maximum safe operating time is reached at any speed, circuit breaker opens to turn off power supply.

Because of high intensity and short duration of flash, instrument can be used also as a light source in high-speed photography where motion of subject is too fast to be stopped by commercial speedlights. Manufacturer: General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

For additional information circle MD 47 on Page 175

HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

71. Bearing Bronze

Bearium Metals Corp. — 6-page illustrated folder "Bearium Metal" describes frictional properties of this material and shows typical bar stock sizes and individual castings. Photomicrographs show structure and lead distribution achieved in this metal which adapt it for use as bearings, bushings and thrust washers.

72. Hydraulic Cylinders

Hannifin Corp.—62-page illustrated bulletin No. 110 on double-acting hydraulic cylinders presents complete source of information and data for design engineers as well as material of value to engineers in charge of installation, operation and maintenance of hydraulic power equipment.

73. Tachometers

Chicago Electric Tachometer Co.—4-page illustrated bulletin No. 12 describes portable and permanent installation type electric tachometers for measuring speeds up to 8000 revolutions per minute.

74. Lock Nuts

Stover Lock Nut & Machinery Corp.—4-page illustrated folder shows design of lock nut, explains principle on which it operates, indicates applications and gives specifications for nuts ranging from ¼-20 to 2-4½ size in standard coarse thread series and from ¼-28 to 1½-12 size in standard light fine thread.

75. Protective Finishes

Mitchell-Bradford Chemical Co. — 20-page booklet "Protective Finishes for Metals" describes Black-Magic black oxide process for blacking steel and iron, process for applying rich black to zinc base diecastings and zinc and cadmium plated fabrications, low temperature black oxide process for copper and brass, final protective film finishes, metal cleaners and finishing equipment.

76. Industrial Instruments

Taylor Instrument Cos.—Illustrated bulletin No. 98170 is revised edition of "Taylor Guide to Correct Instrument Selection" which describes entire line of industrial instruments, explains field of application of each type and covers principles of operation and range limits.

77. Investment Casting

Beryllium Corp.—4-page illustrated bulletin No. 11 presents complete data on use and cost-saving possibilities of precision-cast beryllium copper for industrial and novelty parts. Included are typical mechanical properties and accepted processing techniques.

78. Hydraulic Gear Pump

Hydraulic Equipment Co.—4-page illustrated catalog P-3000-R is guide to Hydreco 3000 series high-pressure oil hydraulic gear pumps for replacement of prior 300 series pumps. With maximum operating pressure of 1000 pounds per square inch, pumps have capacities from 15.5 to 64.0 gallons per minute in six basic sizes.

79. Welded Steel Tubing

Ohio Seamless Tube Co.—40-page technical handbook No. E-4 presents information on electric welded steel tubing made from either cold or hot rolled carbon steel. Data are given on mechanical properties, size ranges, tolerances for various grades and mill practice. Included also are several useful tables and check list to simplify placing orders or submitting inquiries.

80. Motor Control

Westinghouse Electric Corp.—23-page illustrated booklet B-4112 discusses Mot-O-Trol packaged electronic adjustable speed drive for precise control of direct current motors operated from alternating current sources. It is divided into three sections, first of which explains principles of operation; second, construction and maintenance; and third, technical and application data.

81. Centralized Lubrication

Farval Corp.—8-page illustrated booklet entitled "Studies in Centralized Lubrication" presents lubrication case studies which were conducted in various types of plants including paper, metalworking and power.

82. Torquemeters

Baldwin Locomotive Works—4-page illustrated bulletin No. 275 covers four standard Baldwin torquemeters of 2000, 5000, 12,000 and 30,000-pound-inch capacity, specially designed torquemeters for capacities of 30 to 750,000 pound-inches, and instrumentation for indicating and recording torque measurements.

83. Conveyor Chains & Sprockets

Diamond Chain Co.—28-page illustrated bulletin No. 29 presents data on steel conveyor chains available with from 1 to 4-inch pitch, conveyor chains with extended pins, stainless steel and bronze conveyor chains, attachment links, top plate chain, and sprockets.

84. Machining Stainless Steels

American Rolling Mill Co.—36-page illustrated booklet entitled '"Machining of Armco Stainless Steels" explains that though procedures for machining stainless steels may be different they need not be difficult. Contents include grades of steel, cutting rates, operating instructions, tool compositions, cutting fluids and tabular data.

85. Variable Speed Tranmission

Lombard Governor Corp.—4-page illustrated pamphlet "Lombard Variable Speed Transmission" describes variable speed reducer which is particularly suitable for installations where ratio of maximum to minimum output speeds is large.

86. Induction Motors

Century Electric Co.—8-page illustrated form No. 942 describes repulsion-start induction-run brush-lifting single-phase motors and presents advantages of this type motor for starting and operating industrial, commercial and domestic equipment. Tabular data given include various characteristics of performance, locked rotor torque and locked rotor current.

87. Duplicating Machine

Charles Bruning Co. — 8-page illustrated bulletin No. A-1053 deals with Volumatic model 93 Whiteprinter duplicating machine which can produce unlimited numbers of positive copies of documents and drawings made by pen, pencil, printing or typewriting on transparent or translucent paper.

88. Micro Film File

Eastman Kodak Co.—12-page illustrated pamphlet describes Kodagraph Microfile equipment for business and industry. Four models of machines are listed as well as Microfilm reader, enlarger and projector.

89. Pushbutton Stations

Cutler - Hammer, Inc. — Folder entitled "Pushbuttons Unlimited" discusses combinations and features of line of standard and heavy-duty pushbutton stations.

90. Glass Fiber & Nylon Fabrics

Duplan Corp.—8-page revised bulletin illustrates and describes Fiberglas and nylon fabrics for industrial uses. Technical data table lists tensile strength, air permeability, chemical and heat resistance, elasticity, dielectric strength and like factors.

91. Mechanical Differentials

Arma Corp.—4-page illustrated circular "Arma Mechanical Differentials" presents information on high-precision calculating mechanism to combine algebraically two mechanical quantities measured by angular displacement.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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92. Roller Bearings

Shafer Bearing Corp.—30-page illustrated catalog No. 48 presents engineering data on normal and standard duty roller bearing units including pillow block, flange units, flange units with pilot, cartridge and flange cartridge units, take-up units, duplex units, take-up and frame units and bearings as well as adapter mounting heavy duty pillow blocks and radial-thrust roller bearings.

93. Silicone Rubber

General Electric Co.—24-page illustrated bulletin No. CDP-584 describes heat-resistant, mechanical, electrical and chemical-resistant properties and applications of G-E silicone rubber. Fundamentals of silicone chemistry and performance of rubber under varied conditions are discussed. Property tables are included for reference.

94. Leather Belting

American Leather Belting Association—8-page illustrated booklet "Plan to Drive with Leather Belting" suggests how flat leather belts can be used to advantage in driving various types of machines. Adaptability of leather belting to high production requirements, sudden shocks, overloads and long continuous service is discussed.

95. Precision Hardness Testers

Ames Precision Machine Works—12-page illustrated catalog describes methods of operation of hardness testers and provides conversion chart specifying penetrator and correct kilogram loads to use. Reading directly in Rockwell hardness scales, instruments test round and flat stock, tubing, wire and odd-shaped pieces of various materials.

96. Porous Bronze Bearings

Bound Brook Oil-Less Bearing Co.—16-page illustrated booklet "Stock List No. 3" lists sizes and types of Compo oil-retaining porous bronze bearings carried in stock. Information on bearing formulas, tolerances, loads and specifications is given also.

97. Flexible Metal Hose

Chicago Metal Hose Corp.—68-page illustrated catalog G-50 contains full description and complete specifications for standard types of flexible metal hose in variety of metals. In addition it contains sections on expansion joints for piping systems, stainless steel and brass bellows and various conduits and special assemblies of these components.

98. Fluid Drive

American Blower Corp.—18-page illustrated bulletin No. 7519 presents comprehensive data on Gyrol type T fluid drive for internal combustion engines. Use on power shovel, locomotive, earth mover, muck loaders, rotary drier, portable drill rig and heavy marine and stationary engines is covered.

99. Spacer Tubes

Stripmatic Products Inc.—1-page illustrated leaflet covers specifications and applications of precision formed brass, bronze, steel and aluminum spacer tubes. Facts about butted tubes, seamless and welded tubing and pipe are given as well as data on formation with special seams, pierced holes, notches and slots.

100. Direct Current Timing Motors

Haydon Mfg. Co.—8-page bulletin presents information and technical data on direct current motors for timing applications. Performance characteristics of the Haydon 9200 series direct current motor are given, including specifications, applications, speed regulations and methods of determining speed and current.

101. Stampings, Forgings & Assemblies

Commercial Shearing & Stamping Co.—32-page illustrated catalog gives details of typical stamped, forged and assembled parts which have been produced to user's specifications. Brief descriptions are given on hydraulic pumps, motors, cylinders and controls.

102. Nickel Alloy Tubing

Superior Tube Co.—16-page illustrated catalog section No. 10 on nickel and nickel alloy small tubing presents tabular data on physical and chemical characteristics of nickel, Monel, K Monel, Inconel and cupro-nickel. Details on selection and application for these alloys have been compiled for easy reference.

103. Selenium Rectifiers

Vickers Electric Div., Sperry Corp.—24-page illustrated booklet entitled "Selenium Rectifiers" presents characteristics, applications and design factors of these units.

104. Hydraulic Resistant Units

Bellows Co.—8-page illustrated Bulletin HC-600 describes Hydro-Checks for precision control of air power in air motors, feeds and cylinders. Method of operation, applications, dimensions and mountings are shown for stop checking and skip or intermittent checking.

105. Hermetically Sealed Relays

Automatic Electric Co.—4-page illustrated circular No. 1700 describes line of hermetically sealed relays which are protected from moisture, ice, fungi, acid, salt and varying air pressure.

106. Steels

Jessop Steel Co.—16-page booklet deals with leading brands of Jessop stainless and heat resisting steels, tool and die steels, and cast-to-shape steels. Typical analysis and applications are included for each brand.

107. Copper, Brass & Bronze

Revere Copper and Brass Inc.—63-page booklet entitled "Fundamental Characteristics of Revere Metals" gives in nontechnical language basic technology of copper, brass and bronze. Subjects covered include cold working and hardness, annealing, corrosion and specifications.

108. Metal Stamping Dies

HPL Mfg. Co.—4-page illustrated folder explains uses of temporary dies for small-quantity or experimental production. Information on blanking, piercing, forming and other operations is given, as well as data on cold-punchable material from which parts can be produced.

109. Iron Cores

Stackpole Carbon Co.—16-page illustrated engineering bulletin RC 7B gives specifications, production data and applications of end and side-molded iron cores, iron sleeve cores, threaded type iron cores and cup cores.

110. Lubrication Devices & Seals

Gits Bros. Mfg. Co.—16-page illustrated "Price Guide Catalog" is convenient reference and buying guide for oil hole covers, oil cups, bottle oilers, multiple oilers, oil gages, grease cups, accessories and shaft seals.

111. Solenoid Valve

Allied Control Valve Co.—4-page illustrated bulletin No. 462 deals with type V5-100 three-way two-position solenoid valve designed for applications requiring minimum of maintenance and which will operate dependably at maximum pressure of 150 pounds per square inch.

112. Magnetos

Bendix Aviation Corp.—32-page illustrated catalog KM2 depicts and describes Bendix-Scintilla K-magnetos designed to meet variety of one, two, and four-cylinder engine ignition requirements. Specifications and installation details are given.

113. Miniature Ball Bearings

Landis & Gyr Inc.—8-page illustrated catalog No. 6 contains technical data on more than 200 types and sizes of ball bearings with outside diameters from 0.044-inch up in pivot types and from 0.118-inch up in radial types with inner race.

114. Measurements of Thickness

Sperry Products, Inc.—4-page illustrated bulletin No. 3700 explains how Reflecto-gage portable ultrasonic instrument provides accurate visual indications of thickness of metals and other materials from one side only.

115. Flexible Couplings

Chain Belt Co.—8-page illustrated bulletin 48-6 lists uses and advantages of roller chain couplings. Types, dimensions, horsepower ratings, service factors and list prices are included.

116. Reproduction Equipment

General Aniline & Film Corp.—4-page illustrated folder describes features of Ozalid Super-B reproducing machine for making prints on sensitized papers, cloths and films. Specifications, performance data and applications are discussed.

117. Electric Contact Controller

Taylor Instrument Cos.—4-page illustrated bulletin No. 98098 describes Taylor electric contact indicating or recording controller for on-off applications involving temperature, pressure, flow, liquid level or humidity. Photographs and drawings show construction and applications.

118. Electronic Tube Insulators

American Lava Corp.—4-page illustrated bulletin No. 245 discusses characteristics and applications of AlSiMag pressed ceramic and Lava steatite electronic tube insulators and presents chart of their mechanical and electrical properties.

119. Motor and Generator Brushes

National Carbon Co.—Catalog Section B-2106 outlines method of standardization of carbon, graphite and metal-graphite brushes for motors and generators. Simplified RC number system reduces brush stocks to small number having predetermined and unified specifications.

120. Lever Design

Lincoln Electric Co.—2-page illustrated machine design sheet No. 101 describes and shows design of electrically welded levers. Elements of levers, hub design, types of struts, and linkage connections are explained.

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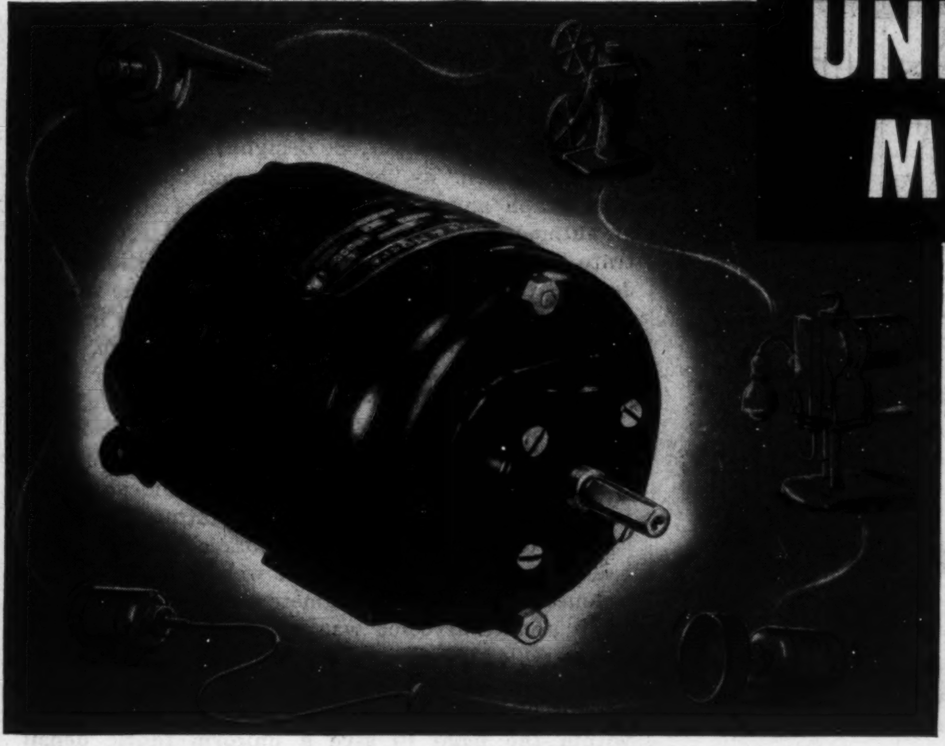

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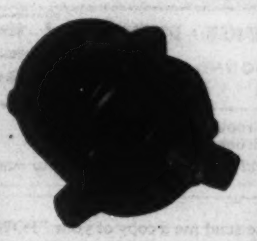

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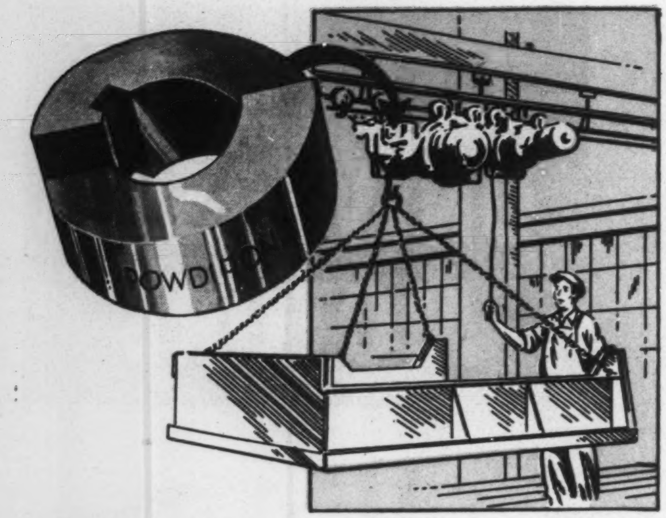

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Molded Laminates

(Concluded from Page 113)

the exception that additional narrow strips of impregnated fabric (in this case glass cloth) are placed in the stack-up to give extra body at those points where the strengthening ribs and bosses appear on the inner surface of the hollow half-cylinder.

Second, the mold may be designed so that the laminations "bunch" or "buckle" into mold recesses. The photograph and exaggerated cross-section sketch of an automobile distributor part, shown in *Fig.* 4, illustrate how the top laminations loop up in the mold to develop the extra thickness required at the apex of the angle. Third, the stack-up may be quite intricate as shown in the sketch of *Fig.* 5, to produce, in the mold, the complex part (a stocking examiner form) shown in *Fig.* 6. Other examples of interesting stack-ups are shown in *Fig.* 7.

When extremely bulky parts are required, the molded-macerated method is often the ideal answer. In *Fig.* 8 are shown two typical rotating parts made by this technique. Complete spheres (for disposable ball-valve constructions in oil well lining tools) are produced similarly in diameters up to four inches. Since a natural color was specified for the stepped V-belt pulley shown at the left of *Fig.* 8, it is possible in the photograph to see the actual flakes of fabric, and to picture how easily they adjusted themselves within the mold to give a uniform fabric density throughout the part. The V-grooves were machined, both for the sake of most economical mass production, and intentionally to expose the ends of the fibers of the filler at the surfaces of belt friction to insure superior grip. In both cases the holes were molded; the keyway in the stepped pulley was broached.

As regards nature of resin, part color, and type of filler, the full range characteristic of the laminated plastics industry can be specified for either molded-laminated or molded-macerated production cycles.

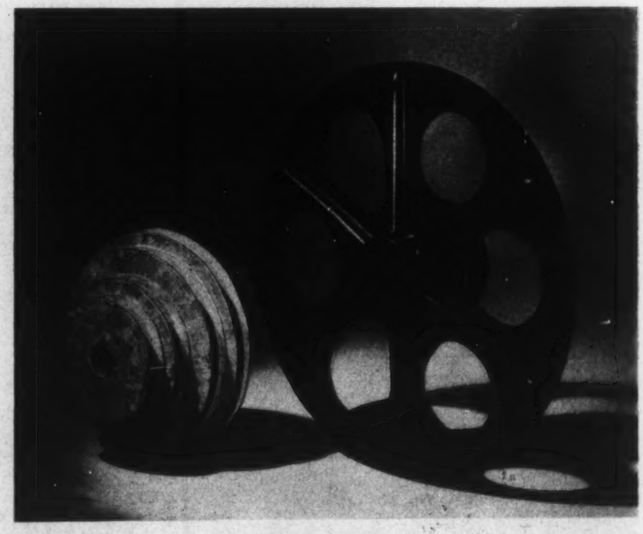

Fig. 8—Parts produced by molded-macerated method. Holes in both parts were molded; keyway in V-belt pulley was broached; its grooves were machined

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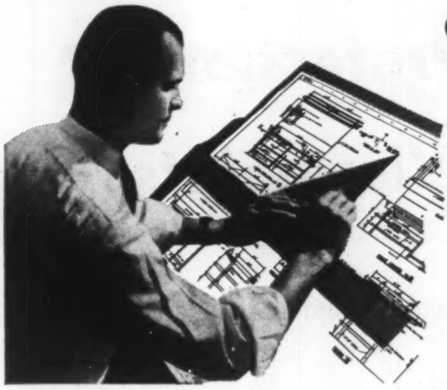

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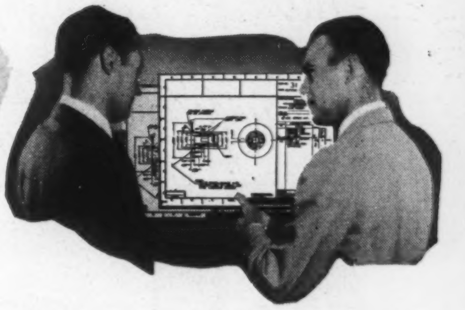

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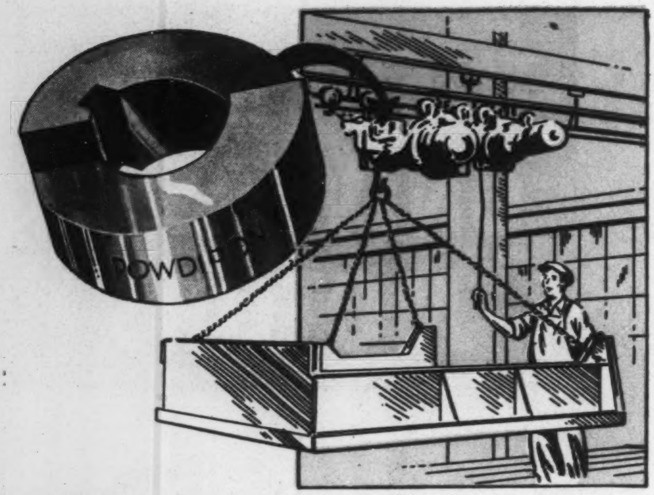

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Molded Laminates

(*Concluded from Page 113*)

the exception that additional narrow strips of impregnated fabric (in this case glass cloth) are placed in the stack-up to give extra body at those points where the strengthening ribs and bosses appear on the inner surface of the hollow half-cylinder.

Second, the mold may be designed so that the laminations "bunch" or "buckle" into mold recesses. The photograph and exaggerated cross-section sketch of an automobile distributor part, shown in *Fig.* 4, illustrate how the top laminations loop up in the mold to develop the extra thickness required at the apex of the angle. Third, the stack-up may be quite intricate as shown in the sketch of *Fig.* 5, to produce, in the mold, the complex part (a stocking examiner form) shown in *Fig.* 6. Other examples of interesting stack-ups are shown in *Fig.* 7.

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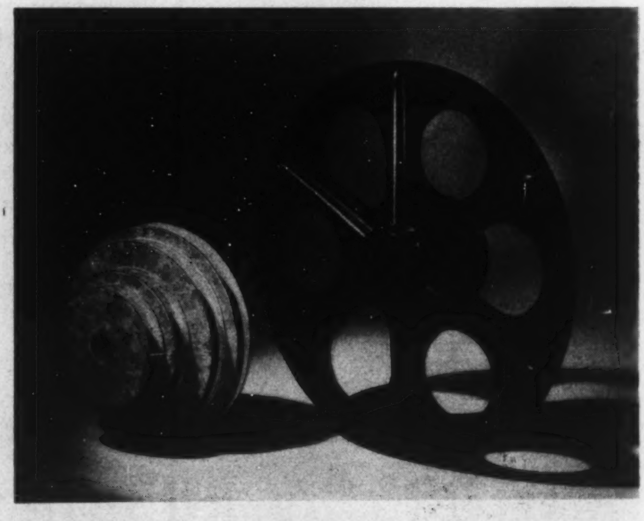

Fig. 8—Parts produced by molded-macerated method. Holes in both parts were molded; keyway in V-belt pulley was broached; its grooves were machined

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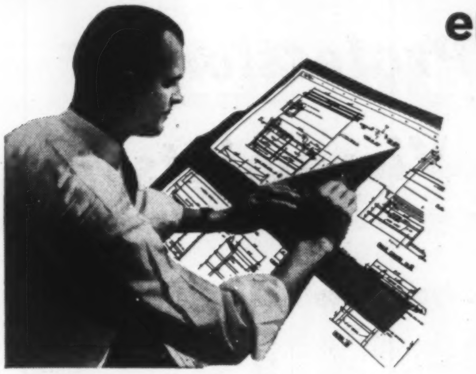

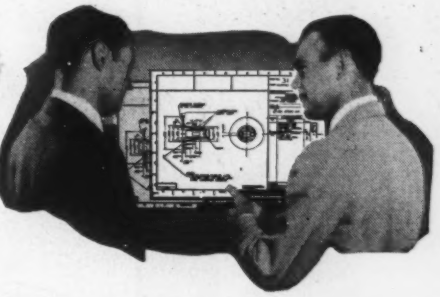

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Professional Viewpoints

"....doubt advantages of Mercury cam"

To the Editors:

In the February issue of MACHINE DESIGN, Mr. R. J. Jacobs in his article on turret indexing mechanisms claims certain advantages for the "Mercury" cam, i.e., a concave barrel cam and driven member with rollers placed radially.

I am interested, but I fail to see what advantages are secured which do not obtain with the more usual roller disk and parallel-body barrel cam. Furthermore, it would appear to be much more difficult to produce, at least where only one or two are required. It takes up more space radially, as the full diameter of the cam extends outwards from the driven member, as opposed to its radius in the more usual mechanism, and requires a disk with a flange or rim. The usual mechanism is also much more easily adapted to an existing machine, in this case the driven member simply consisting of a ring with rollers attached to the existing spider of the machine, e.g., a lamp-basing and soldering machine or a control machine. I agree that the barrel cam is infinitely more flexible in design than the geneva gear and in its usual form is fairly easily produced. Perhaps Mr. Jacobs can enlighten us further on this matter.

On casual examination of the photograph of the paper container machine on Page 94, I should say there is no reason why the usual disk and straight barrel cams would not suit, but there may of course be a very good reason for this departure.

—ALEX. L. E. WILSON, *Chief Engineer*
British Luma Co-op. Elec. Lamp Soc. Ltd.,
Shieldhall, Glasgow

To the Editor:

In answer to Mr. Alex. L. E. Wilson's letter, may I say that the greatest advantage of the concave barrel cam as compared to the cylindrical barrel cam is reduction in wear of the cam track and added life of the cam follower rollers.

Mr. Wilson is correct in his statement that there is very little difference between the two cams as far as basic operation is concerned. In quite a number of cases it would be a matter of space consideration and layout that would determine which of the two would be most suitable, particularly in the application of cams where followers are closely spaced. In these cases there is little difference in the action in that the concave cam would approach a cylinder in shape.

However, in cases of wide spacing of the follower

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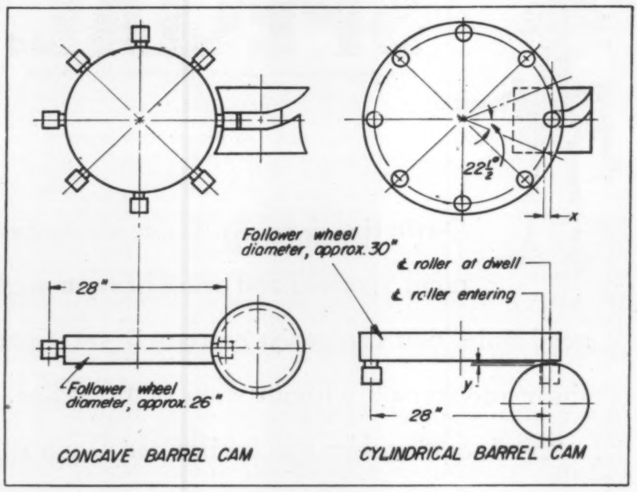
rollers, or in cases of heavy-duty application, the Mercury concave barrel cam is definitely superior.

As the accompanying sketch shows, in the Mercury concave-barrel cam, the cam followers remain at constant depth in the cam track and have full-line contact over the indexing range. It can also be seen that a cylindrical cam would not be practical with this arrangement as the cam followers would withdraw excessively from the track.

An alternate design of a cylindrical indexing cam is also shown in the sketch having the same proportions as the example given in my article. The followers are on a 14-inch mean radius, and the cam mean radius is 5.36 inches. As can be seen from the sketch, at the point of transfer at 22½ degrees in an 8-station index, the cam follower withdraws from the track a certain distance, *y*.



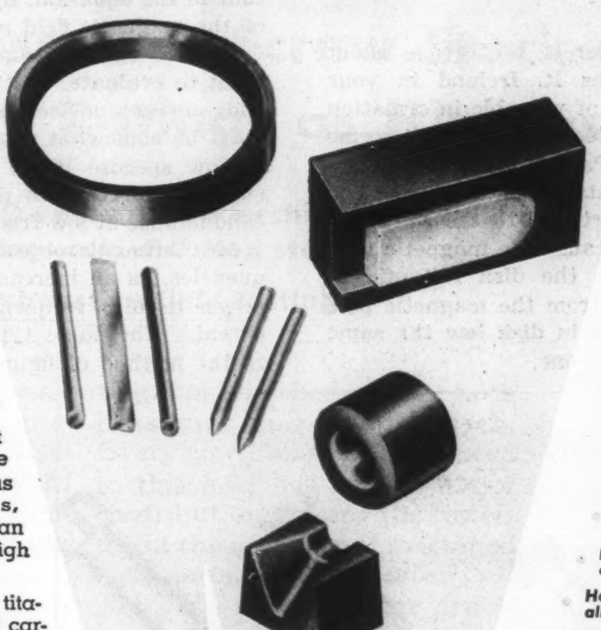
It will also be noted that when the cam followers are on greater diameters, and there are only a few index stations, such as 6, 8 or 10, the barrel cam diameter would have to be excessive in order that the cam followers even remain in the cam track. Withdrawal of the cam follower from the track results in a sliding action of the cam follower on the cam track during indexing when employing a cylindrical barrel cam. If a standard needle-bearing cam follower were used, the rollers would tend to skew in the races. Also there would be wear on the end retainers of the bearing due to the end thrust resulting from this sliding action. The combination of these two conditions would result in lower life of the cam followers. The sliding action of the follower itself on the cam track would result in accelerated wear on the cam track.

A further general advantage of the Mercury cam over the cylindrical barrel cam is the possible reduction in size of the follower wheel and the attendant reduction in inertia.

It should be interesting to note that the large turret on the paper container machine pictured on Page 94 of the February issue is 48 inches in diameter, has 20 stations, weighs over 1000 pounds, and indexes under normal operation at about 75 indexes per min-

100,000 PSI at...

1800°F.



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	1800°F.	100	100
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Compressive Strength 1,000 psi		550	—

ute. This machine has been in operation 16 hours a day for about two years and neither the cam nor the rollers have shown any sign of excess wear or failure. Cutting of the Mercury cam in low-production quantities is performed very satisfactorily on standard horizontal boring machines.

One other feature of the concave barrel cam is that it offers a different arrangement in location of the camshaft with respect to the follower wheel shaft. In some cases design complications may arise in the use of the cylindrical barrel cam because of the proximity of the follower wheel shaft to the outside diameter of the cam.

—R. J. JACOBS, *Chief Engineer*
Mercury Engineering Corp.

". . . . formula contains error?"

To the Editor:

I have read with great interest the article about permanent magnets by James R. Ireland in your April issue. It contains a lot of valuable information on the design of magnetic devices. However, it seems to me the formula given on Page 224 for the torque in eddy-current clutches contains one error. The torque is definitely not proportional to the thickness of the disk as given there, because the magnetic field and the eddy currents inside the disk fall off exponentially with the distance from the magnetic pole shoe. In most cases a very thin disk has the same effect in practice as a very thick one.

Furthermore, there is often a considerable reaction effect from the rotating disk which may in cases of high speed cause the torque to drop again. This negative characteristic of eddy-current devices operated at high speed can easily cause violent oscillations or hunting.

I would say that the formula given on Page 224 for torque is a good approximation in the case of an eddy-current device with slow speed and low number of poles, if you omit the thickness of disk, *t*, from the formula.

—ALFRED S. GUTMAN
Brookline, Mass.

To the Editor:

Mr. Gutman's comments on the eddy-current torque formula are greatly appreciated. May I point out that in the equation, *B* was defined as the flux density of the magnetic field passing *through* the disk. It is quite true that this quantity may be somewhat difficult to evaluate. Although we are not specialists in eddy-current devices, it seems to us that the torque must be somewhat proportional to the disk thickness at low speeds—if we accept this definition of *B*—since an increase in disk thickness will increase its conductance at low frequencies.

Mr. Gutman's objection is quite valid at high frequencies, as an increase in disk thickness will not increase its high frequency conductance to a very great extent. The same type of objection could be made to the method of figuring voltage output for an elec-

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tric generator as set forth in any physics or electrical engineering text. We know from experience with high-frequency generators that eddy currents in the stator invalidate voltage calculations made in the usual manner.

—JAMES R. IRELAND, *Chief Engineer*
Thomas & Skinner Steel Products Co.

". . . . may lead to misunderstanding"

To the Editor:

Mr. Elberty's article, "Clutches", in the May issue of MACHINE DESIGN, presents a new and unique conception of the mechanism of magnetic-fluid clutch action in his "chain" theory. This theory has experimental justification in microscopic examinations and observance of the chain formation under influence of a magnetic field as reported by Rabinow of the Bureau of Standards. However, the uniformity of the iron-oil mixture's permeability over wide ranges of magnetization, which is mentioned as "additional experimental data" tending to support the theory, is itself subject to experimental justification. The clutches certainly act as though the mixture has nearly constant permeability, yet no data or magnetization curves for the mixture, together with a description of the test methods, have been published so far as I know.

In determining the relations whereby he establishes the relative areas and proportions of the gap and iron core areas, Mr. Elberty has not included the reluctance of the clutch gap as a part of the total reluctance of the magnetic flux path. This omission may lead to some misunderstanding because any practicable clutch gap will have an appreciable reluctance, even if the mixture permeability is eight times that of air. Furthermore if the permeability is roughly a constant, as is indicated, the clutch gap will tend to act on the overall circuit magnetization characteristics in much the same fashion as an air gap; namely, to introduce more linearity into the curve of flux density vs. magnetomotive force (B vs. H).

If Mr. Elberty's contention holds true, that torque varies proportionally with flux density, the torque-current curves of a clutch should be even more linear

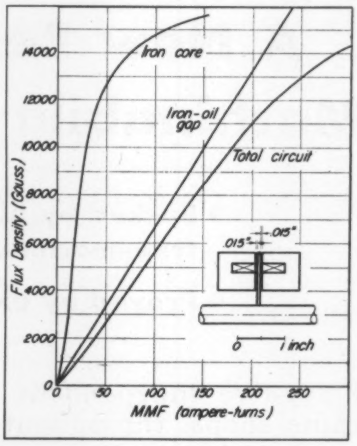

Fig. 1—Magnetic circuit reluctance, calculated on the assumptions of no leakage or fringing flux, and iron-oil permeability eight times that of air

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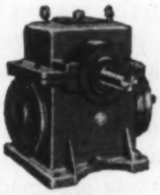
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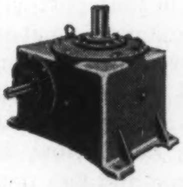
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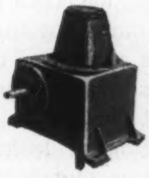
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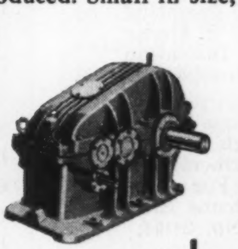
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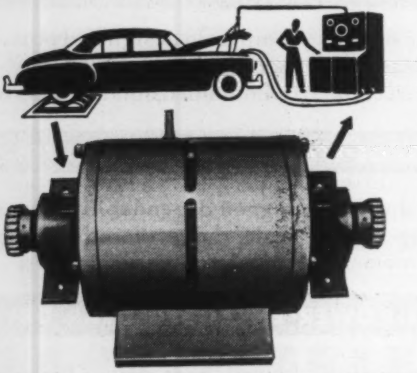

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than is observed. The shape of the reluctance curve of the iron core has a slight upward curvature near the origin, *Fig.* 1, followed by an almost linear portion until saturation introduces the characteristic leveling off, and the so-called knee of saturation appears as a rounding of the curve toward a limiting value of flux density. When a linear iron-oil gap is added in series with the iron core, the circuit reluctance curve has an altered slope, the up-curve near the origin is less apparent, the linear portion becomes more linear, and the knee becomes more gently curved near saturation. The result, *Fig.* 1, is a curve which is practically a straight line from the origin until saturation begins to show up. If torque is proportional to flux density this would be exactly the shape of the torque-current curve, which nearly always has a distinct upturn near the origin and a sharper curvature at the knee.

A measured torque-current curve on a Raymond Engineering Laboratory clutch is illustrated in *Fig.* 2. This curve shows the characteristic up-turn near the origin, which is definitely not linear and is more than can be explained by residual magnetic or fluid drag. Also, the portion just below the knee is fairly linear, but then so is that portion of the magnetization curve for the iron core, as shown in *Fig.* 1, which gives calculated curves for the reluctance of the magnetic circuit, based on permeability of the mixture eight times that of air, and making no allowance for fringing or leakage flux. Now, if a linear relation between clutch torque and flux density is assumed, a curve for torque vs. current may be derived, shown in *Fig.* 2 superimposed upon the experimentally measured curve, with suitable scale factors to obtain equivalent torques for 31 ma of current. Also on *Fig.* 2 are plotted points for a similarly derived curve based on the shear-stress vs. flux-density curve for a 0.020-inch gap shown in *Fig.* 3. This last figure gives data taken on a clutch whose flux-density vs. current characteristics were known from calibration measurements for the various gaps used.

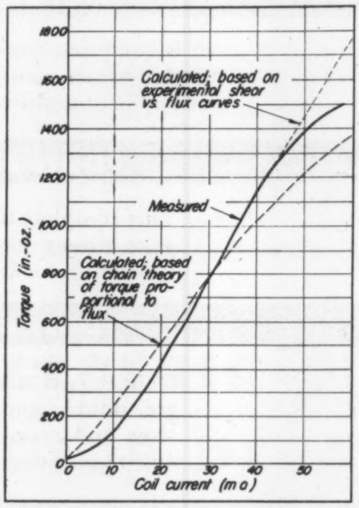

Fig. 2—Static torque characteristics of magnetic-fluid clutches

These data indicate the shear stress to vary as the 1.3 to 2 power of flux density; if this sort of rela-

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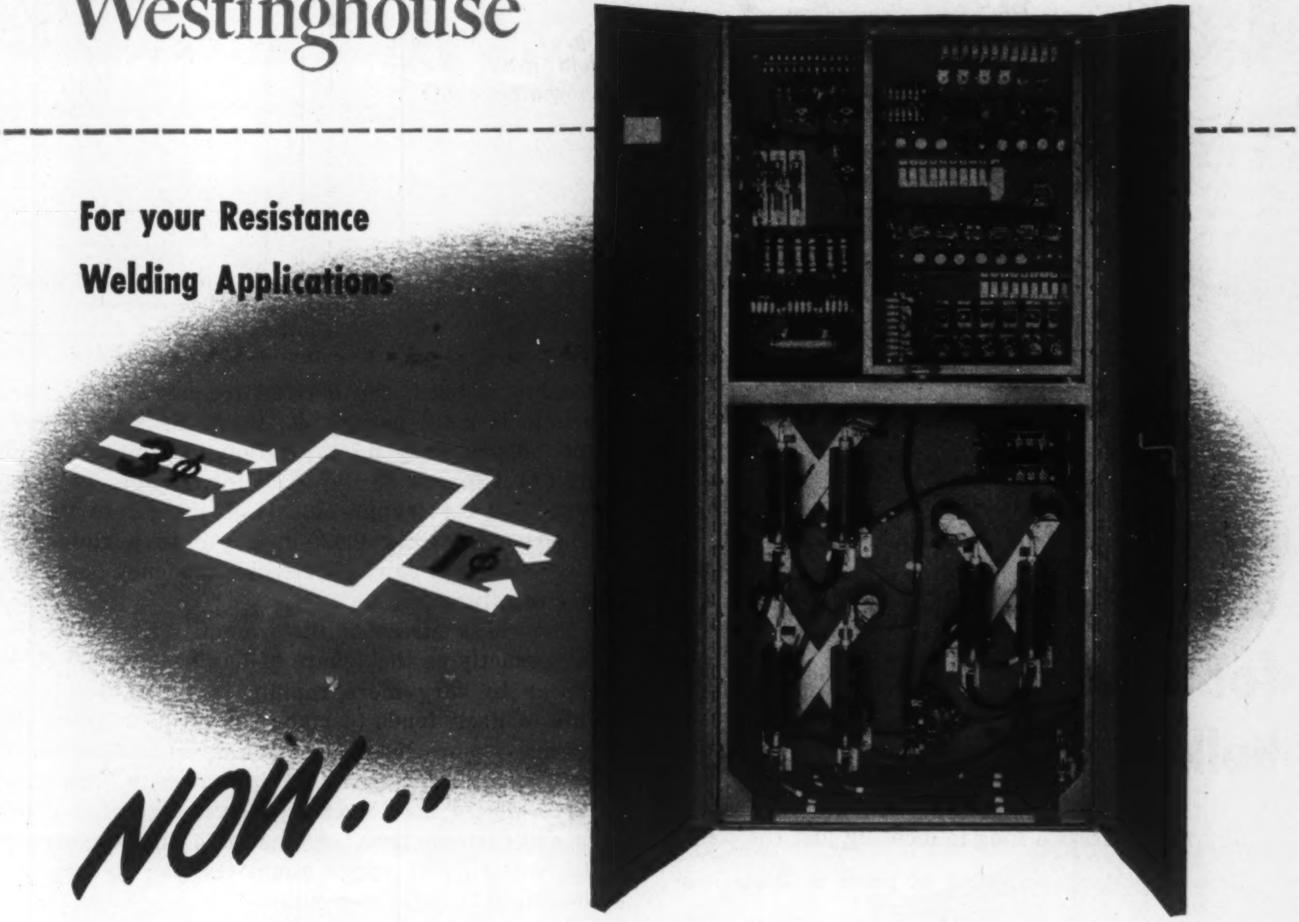

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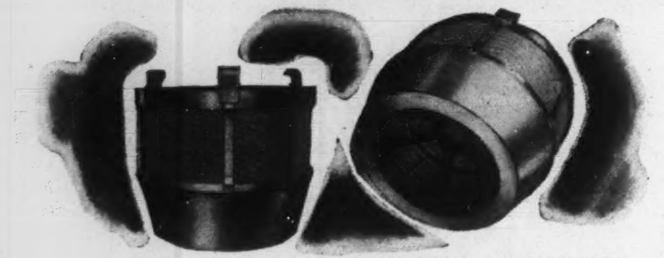

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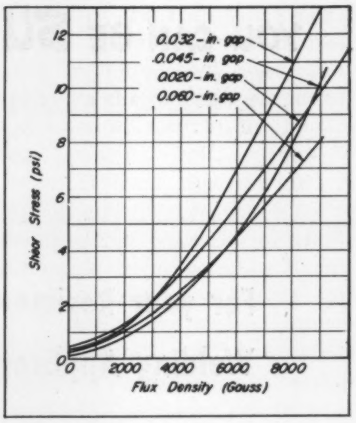

Fig. 3 — Magnetic fluid static shear characteristics

tionship is used, the derived torque-current characteristic is more nearly like the measured. There is some discrepancy as saturation is approached, due to: (1) The lack of allowance for fringing or leakage flux; (2) the inapplicability of the stress vs. flux-density curves for 0.020-inch gap to a clutch with 0.015-inch gap, or (3) a possible tendency of the mixture to saturate.

The shear stress of the iron-oil mixture may not vary exactly as the square of flux density, but it does appear to vary more rapidly than the first power. This in itself tends to make the torque-current characteristic more linear just below saturation, because the rising characteristic of the stress vs. flux-density curve offsets the decreasing slope of the flux-density vs. coil-current curve. At the same time, the exponential variation of stress simulates the up-curve near the origin of the clutch curve.

In conclusion, let me add that these comments are not made with the intention of criticizing or discrediting Mr. Elberty, who is to be congratulated for his original thinking about the problems and principles of magnetic-fluid clutch design. The chain theory he presents is extremely interesting and should stimulate many other investigators. There may be evidence tending to support the chain theory, but two points mentioned in Mr. Elberty's article—constant permeability of magnetic fluid and linearity of clutch torque with current—do not seem to be completely sufficient. The latter contention, in particular, does not seem to be as true experimentally as the theory would indicate.

We are continuing our investigations here to try to increase our knowledge of clutch design factors by experimental studies of clutches specially constructed to facilitate observation of the effects of several variables on performance. In this fashion we hope to obtain a better determination of the behavior of the magnetic fluid and to be in a positon to shed more light on the subject of Mr. Elberty's theory.

—P. D. Tilton
Servomechanisms Lab.,
Massachusetts Institute of Technology

To the Editor:

In Mr. Tilton's comments, he is pointing out that there is lack of evidence to support the theory of chains of magnetic particles. This theory was ad-

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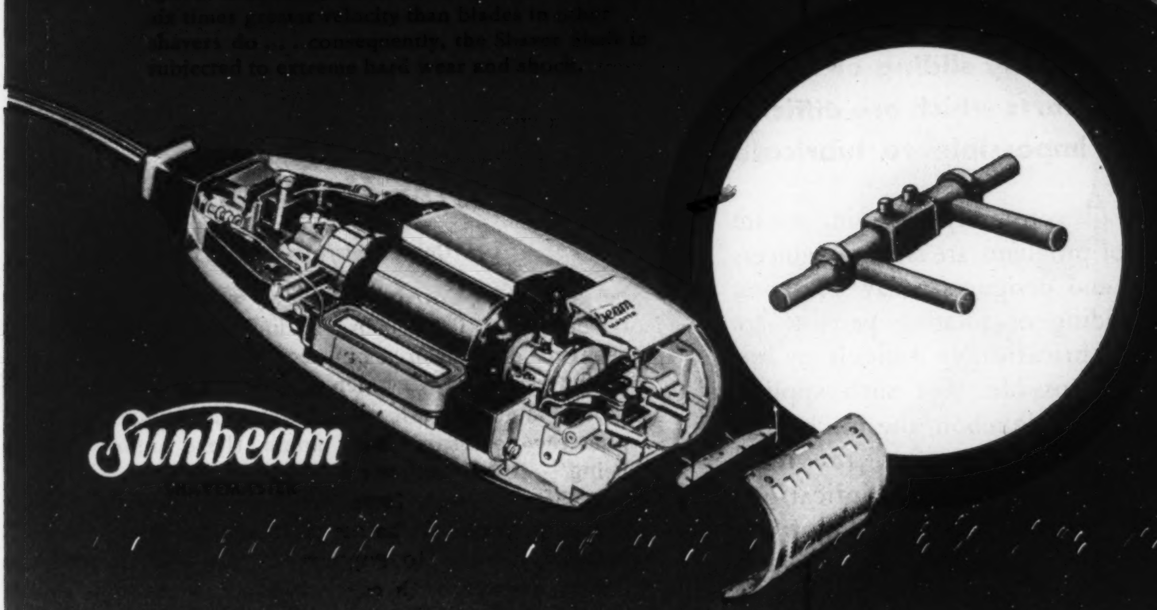

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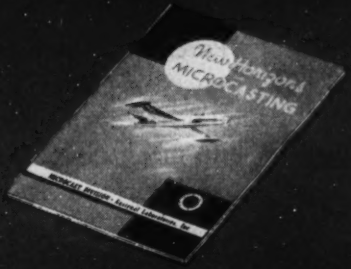

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vanced to provide an explanation for the experimental result that the clutch torque does not follow the square of the flux density in the magnetic fluid. I do not agree with the comment of Mr. Tilton since a very considerable chain of coincidences would have to occur in order to obtain the straight-line torque performance and still follow the square law of magnetic attraction. In short, the magnetic permeability of the circuit, plus the magnetic fluid, would have to vary as the reciprocal of the ampere turns to obtain the actual performance and still support the square law. Therefore, it is my opinion that this is too much of a coincidence with all of the clutches that we have tested.

True, there are not too much data to support the theory that I have advanced and I am sure that Mr. Tilton will investigate this theory and devise some methods of his own for supporting it or knocking it down.

—R. S. ELBERTY, *Consulting Engr.*
Raymond Engrg. Laboratory, Inc.

Plaster-Mold Castings

(Continued from Page 118)

be provided. Cored dimensions within a casting can be held to ±0.005-inch per inch when formed by a separate core. Cored out sections of castings formed by a "green core", which is a part of the main body of the mold, can also be held to 0.005-inch per inch, plus the necessary draft angle, these angles usually being ½ to 1 degree per side.

Designers need have no fear of intricate cored castings, provided the cores to produce them are substantial enough to support themselves. Undercuts can be formed with cores, but not with loose pieces on the pattern. Patterns must be in one piece and pull free from the plaster. Plaster cores are easily removed and present no cleaning difficulties. Special coarse-pitch thread forms and spiral grooves can be cast satisfactorily by the use of properly designed coreboxes.

Shown in *Fig.* 7 is a split nut with a special thread cast in. The plaster process substantially reduced the cost of producing this nut and solved a difficult assembly problem. *Fig.* 8 shows a spiral cable groove cast in a controller drum. This was formerly produced by a machining operation but is now formed with a plaster core at low cost.

Designing Is a Compromise

The foregoing deals with a few of the wide and varied uses of plaster-mold castings. No positive set of design rules can be formulated which will determine for each designer whether a plaster casting should or should not be used. Designing a casting for a particular method of casting is, at its best, a compromise between the ideal and that which can be obtained through practical foundry procedure.

All processes have their advantages and disadvantages. These must be carefully balanced one against

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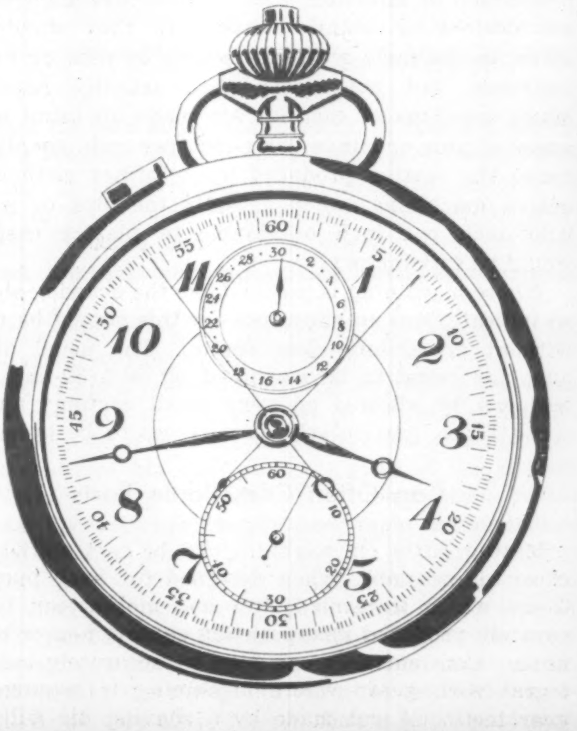

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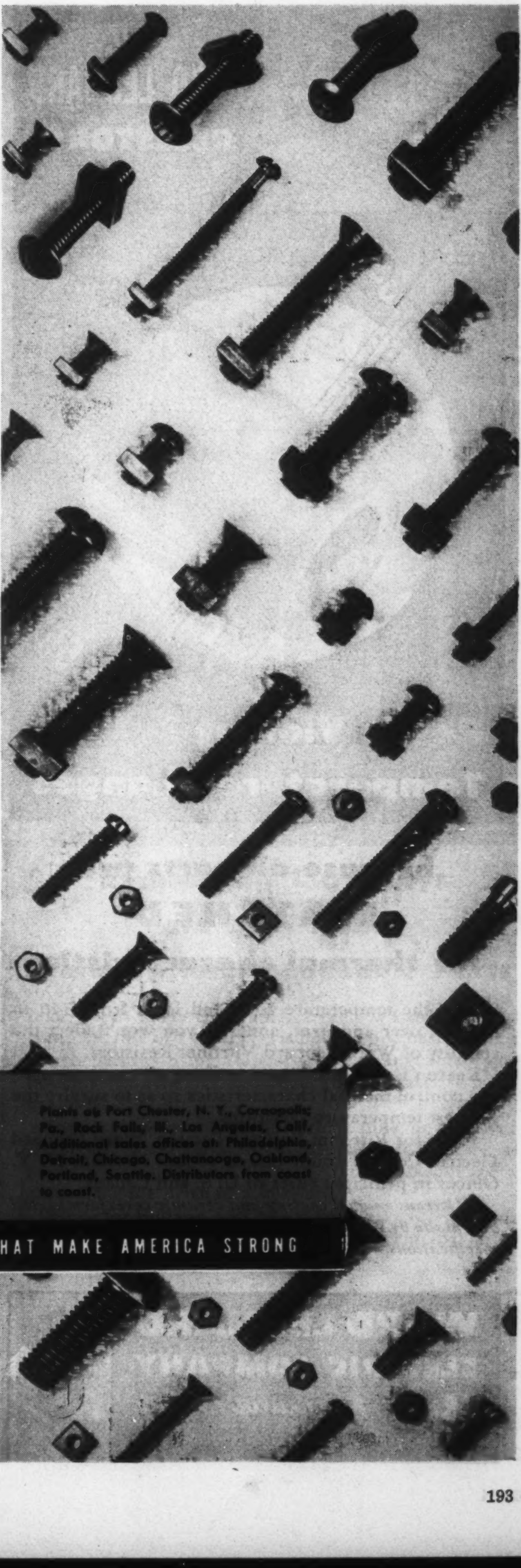

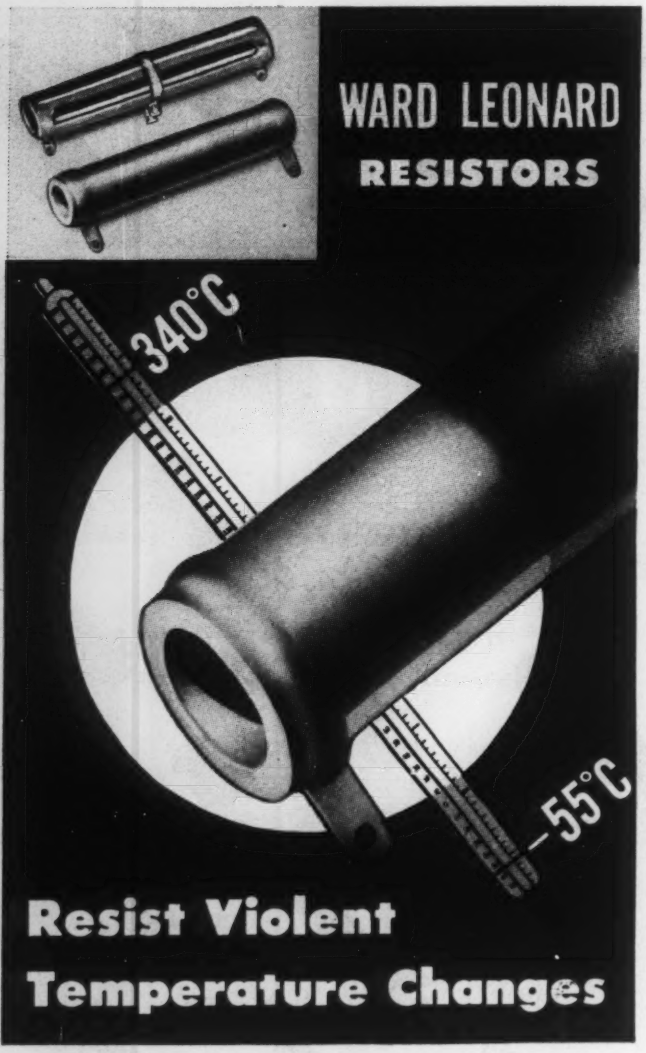

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the other when laying out the original design, since the design itself will largely determine which is the most practical process for producing the part. Keeping in mind a few of the objectives to be attained in the use of plaster castings such as close tolerance, fine detail, smooth surface and lower cost through elimination of machine work, it should not be too difficult for the designer to decide if these are requirements for his casting, and then develop it accordingly.

Considerations of Tolerances

It might be advisable to mention a few fundamental requirements for the successful design of plaster-mold castings. Although tolerance is one of the advantages of the process, it is not wise to specify dimensional tolerances closer than are essential, unless the tolerances are within the range easily held. This is true for all parts designed for production at minimum cost. When close dimensions are desired or definitely essential, they should be given in decimals with the allowable plus or minus tolerance, but not closer than actually required. Many drawings of castings are made up using tolerances of plus or minus 0.001-inch per inch, simply because the casting produced by a former method required machining, when actually the plus or minus 0.005-inch per inch obtainable in plaster castings would be satisfactory.

Where machining is unavoidable the drawing should so indicate, and an allowance for this should be made without demanding close limits. The usual allowance for metal to be machined off is 1/32-inch, but less can be allowed on very small castings and in cored holes, particularly on surfaces to be broached.

Can Often Consolidate Parts

Mating parts on machines can be cast sufficiently close for assembly when designed for such purpose. Gears which transmit power and motion can be accurately produced incorporating square, hex or round hubs. Cam surfaces can also be accurately cast integral with gears where machining is required on gear teeth. A cut made by a shaving die will produce the machined finish. This can also be accomplished in cored holes by broaching and drilling.

It is good practice to consolidate two or more assembled pieces into one cast piece, employing the use of cores where necessary. Holes or cavities formed by loose cores require no draft. Draft must be allowed, however, where the core is a part of the mold body. Patterns also require draft angle to free them from the plaster. When designing for consolidation of several pieces, consideration should be given to brackets and projections for fastening the casting, all of which can be incorporated in the one casting. Screw holes may be cast in, as well as inserts such as pins, arms, and threaded bushings. *Fig.* 9 illustrates an intricately cored casting which incorporates several design functions in one casting.

In many cases the foregoing practices effect economies through the elimination of purchasing separate parts and handling them at assembly. If the saving appears significant it deserves careful consideration, but the matter should be explored thoroughly with the foundry and suitable changes made if consolidation complicates the pattern and casting to an extent that no net gain is possible from the combination.

Small diameter holes which require loose cores can be drilled more economically than a corebox and core can be produced for casting. Holes which are irregular in shape and which cannot be machined may be cast to size with a loose core. Size of a casting is also a critical design factor since the mold size is fixed for a standard production line. Standard mold size is 10 x 18 inches, with a limited depth of 2⅞ inches. This means a casting should not be higher than 1 7/16 inches above the parting line. The mold is made up of strips of various sizes predetermined by the area required for the pattern or patterns, *Fig.* 1. This permits flexibility of operation and does not require large quantity orders.

Are Grouped To Facilitate Production

With the unit strip arrangement, the pattern grouping is varied to suit production schedules. Frequently it is advisable to use multiple patterns in order to obtain more effective utilization of the mold space. When a run with a given pattern is completed, another mounted on the same size strip or area is put in its place. When grouping patterns in a mold they must, of course, all be poured in the same metal specification.

Plaster-mold precision castings are not in the same price category as other types of precision castings. They may be somewhat higher on the average than sand castings, but are below the price of the average precision casting as such. Price computation in the plaster process is primarily based upon the number of square inches which a particular pattern occupies in the mold. Therefore, a light, flat, thin casting will, when compared with other types of castings on a per pound basis, be somewhat higher in price. However, a solid, chunky piece occupying a relative small area in the mold, will, on a per pound basis, be equal to or very little higher than a good sand casting. Hence, it seems desirable for the designer to explore thoroughly the use of plaster-mold castings and to weigh carefully the benefits to be obtained through this production process.

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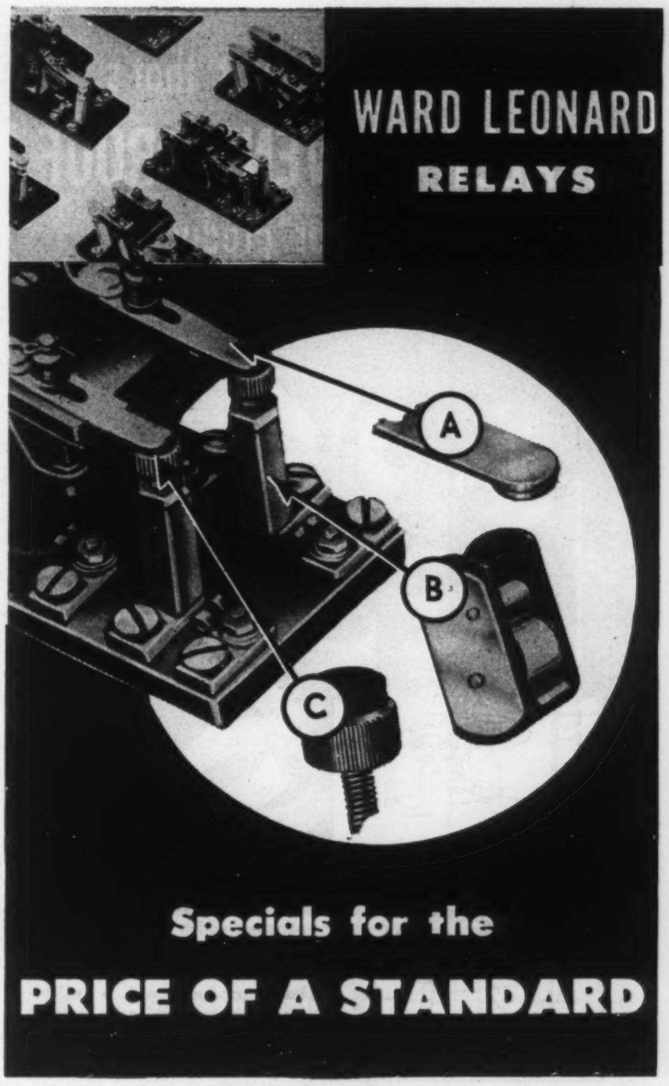

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APPOINTMENT of George A. Spencer to head its Los Angeles sales office has been announced recently by American Nickeloid. As new west coast sales representative, Mr. Spencer will be located at 1323 Venice Blvd., Los Angeles 6, Calif.

◆

Link-Belt Co. has named Allan Craig general manager of their southwestern division with headquarters in Houston, where a new plant is to be opened soon. Mr. Craig, formerly sales manager in Atlanta, is being succeeded by Michael J. Perry, who is to be replaced as district manager at Moline, Ill., by Andrew K. Kolar.

◆

In an effort to meet the motor control needs of the machine tool and air conditioning fields, Cutler-Hammer Inc., Milwaukee, has appointed K. M. Nelson to the post of industry specialist. Appointment of such a specialist is believed to be an important step toward improving old and developing new methods of control.

◆

The states of Florida, Alabama, Georgia, Mississippi, Tennessee, North Carolina and South Carolina will henceforth be served by T. P. Stone and M. J. Cook, new salesmen for the Wolverine Tube Division of the Calumet and Hecla Consolidated Copper Co. Mr. Stone will be temporarily located in Atlantic Beach, Fla., and Mr. Cook will travel out of Jackson, Miss., later moving to Atlanta.

◆

Located at Utica, N. Y., Donald P. Gordon has been appointed resident salesman under the jurisdiction of the Buffalo office of the Berger Mfg. Div. of the Republic Steel Corp.

◆

A Sloan Fellowship at Massachusetts Institute of Technology has been awarded to Joseph F. Hutchinson, sales engineer for the Goodyear Tire & Rubber Co. As one of ten men to receive this award, Mr. Hutchinson will enter an intensive one-year program to study management, economic and social problems of industrial administration at M. I. T.

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The Standard Tube Co. of Detroit has appointed A. R. Schumann, former district sales manager, to the position of manager of sales. Also, L. B. Boensch has been named sales engineer, specializing in stainless and alloy steel tubular products.

◆

With headquarters in Denver, James W. Hepburn has been appointed assistant manager of the Vertical Turbine Pump Division, Worthington Pump and Machinery Corp. Mr. Hepburn will be responsible for customer relations in the sale of vertical pumps in the territories west of the Mississippi River, including Chicago, St. Paul and New Orleans.

◆

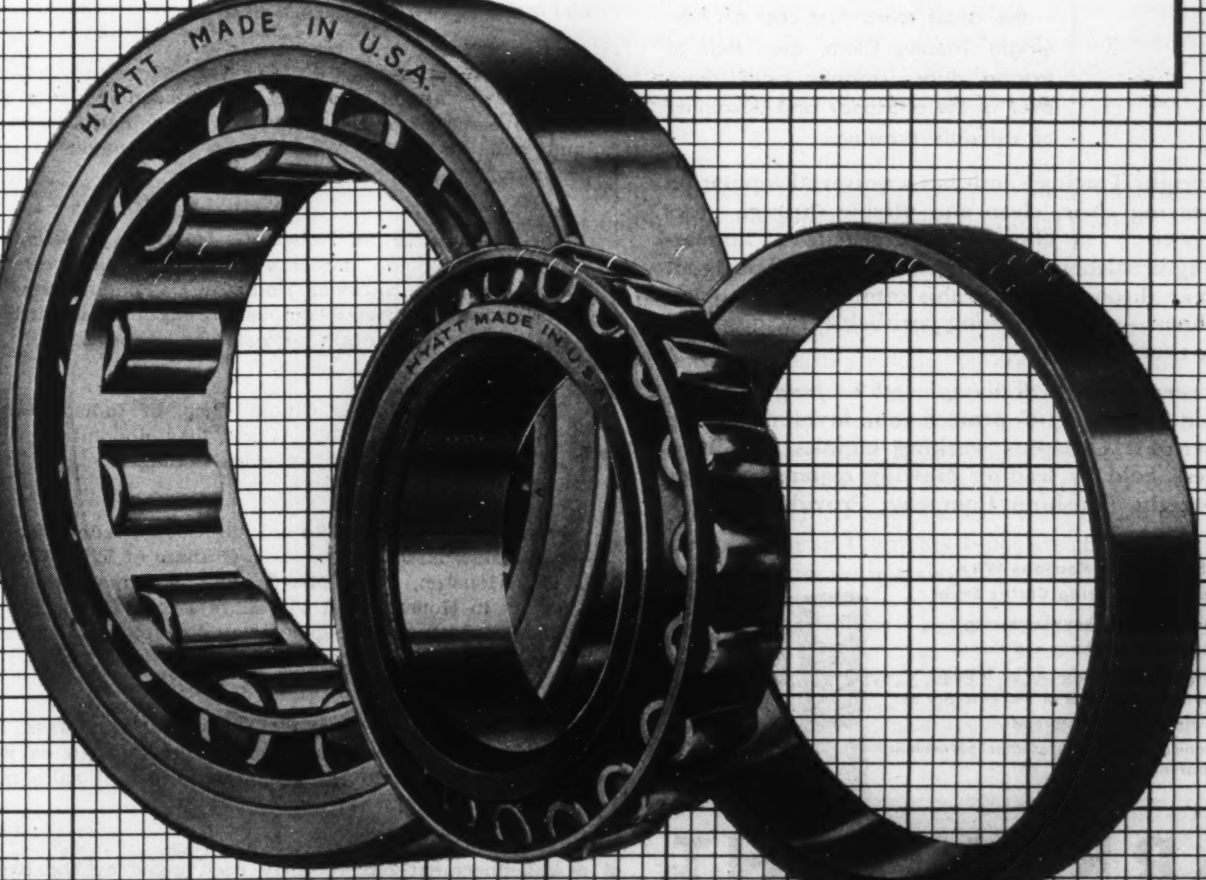
Leland I. Doan, newly elected president of the Dow Chemical Co., has announced the promotion of Donald Williams to director of sales, the position formerly held by Mr. Doan. Mr. Williams was general sales manager

BUILT FIRST ... TO LAST

From the *first* roller bearing available to industry, to the millions now produced annually, Hyatt Roller Bearings have been built to *last.*

For over half a century, Hyatts have been designed into vital positions of all types of mechanical equipment and over the years these dependable Hyatt bearings have run up unmatchable performance records wherever they are in use.

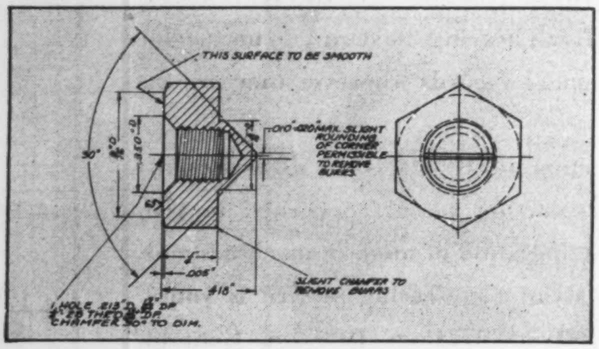
Your selection of Hyatts is an assurance of complete satisfaction to all concerned in the building and operation of modern machines and equipment. Hyatt engineering service is yours on request. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



HYATT ROLLER BEARINGS

with PAINT

— the small extra first cost of test samples pays off in assurance of efficiency and durability of the protected surface.


THIS SURFACE TO BE SMOOTH
.010"-.020 MAX. SLIGHT ROUNDING OF CORNER PERMISSIBLE TO REMOVE BURRS
SLIGHT CHAMFER TO REMOVE BURRS
.005"
.418"
.350" D
90°
1 HOLE .213" D. DP
CHAMFER 90° TO DIM.

with TRACING CLOTH . . .

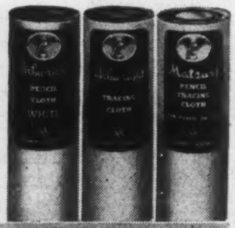
— the small extra first cost of Arkwright Tracing Cloth, over that of tracing paper, repays many times over in the efficiency and durability of valuable drawings.

Arkwright Tracing Cloth has a universal reputation for staying clear, clean and pliable through years of service . . . no ghost-producing spots . . . no tear-causing brittleness. Special mechanical processing all the way through gives it this combined clarity and toughness—out-performing perishable tracing paper many times over.

For every sketch or drawing worth keeping — on the job or in the file — protect your investment with Arkwright! Generous working samples free upon request. Sold by leading drawing material dealers. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.



ARKWRIGHT
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

and will be replaced by Donald K. Ballman in that capacity. Dr. L. S. Roehm will be assistant general sales manager, in addition to remaining in charge of Dow's technical service and development division.

◆

New central division sales manager of the Townsend Co., New Brighton, Pa., is John G. Spruhan. Mr. Spruhan will maintain headquarters in Detroit and will co-ordinate activities of the company's Detroit and Cleveland offices for the sales of rivets, bolts, special metal fasteners and all other products.

◆

Announcement has been made by the Twin Disc Clutch Co. of the appointment of Jack N. Yetter as district sales engineer in charge of the Tulsa, Okla. office and the promotion of Harry Peck to the position of district sales engineer, operating out of the Dallas, Tex. office.

◆

A veteran of fifteen years with the rubber industry, Edward L. Lockman has been made manager of tank lining and roll covering sales for the United States Rubber Co., New York.

◆

The Wellman Bronze & Aluminum Co., Cleveland, has announced the appointment of William A. Muth Jr. as their Ohio representative. He will handle the sales of Wellman's complete range of magnesium, aluminum, bronze, permanent mold and sand castings, and wood and metal patterns.

◆

The National Screw & Mfg. Co., Cleveland, has announced the appointment of H. Robinson Hyde as production manager of the company's main plants in Cleveland, and Samuel M. Washabaugh as manager of sales promotion.

◆

The appointment of Robert G. Harrison as sales representative for the northern Ohio area has been announced by the National Radiator Co., Johnstown, Pa. Mr. Harrison, a former combustion engineer and heating consultant, will maintain heaquarters in Cleveland.

◆

The L. G. S. Spring Clutch Corp. of Indianapolis, a division of Curtiss-Wright Corp., has appointed Albert F. Korf to the position of sales manager.

◆

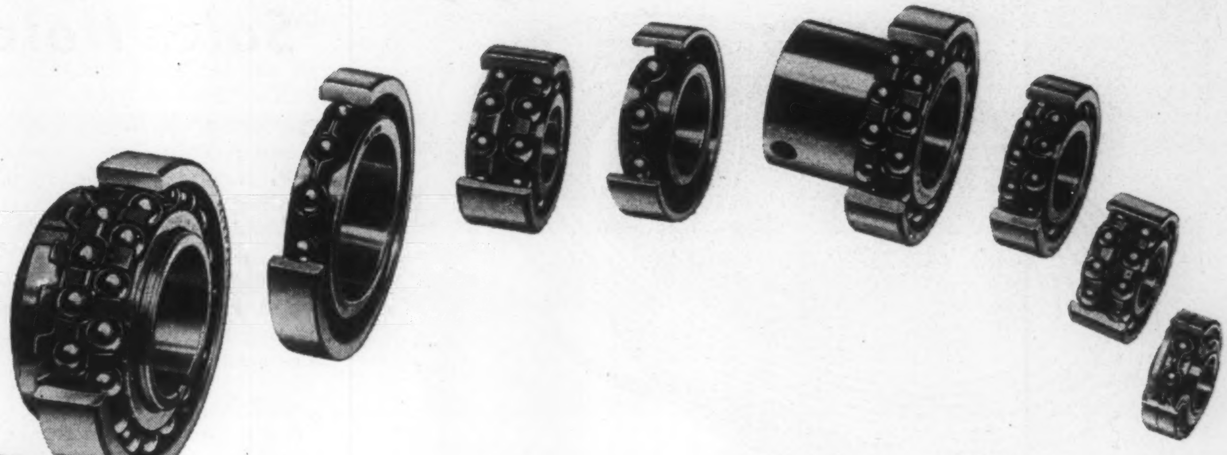
New sales representative for the Cooper Alloy Foundry Co., Hillside, N. J., is Ernest E. Graham of E. E. Graham & Co., Houston, Tex. Mr. Graham will maintain headquarters in Houston and will serve Texas, Oklahoma and Louisiana with the Cooper Alloy line of stainless steel valves, fittings and engineered castings.

◆

The Continental Screw Co., New Bedford, Mass., has announced the appointment of Victor Ladetto as sales manager and Donald H. Sleeper as assistant sales manager.

◆

Announcement has recently been made by the Brown Fintube Co., Elyria, Ohio, of the appointment of E. A. Bertram as manager of sales. Mr. Bertram will be in charge of selling company products in the petroleum and chemical industries. This company has also appointed Laurence C. Johnston district sales manager with headquarters in New York.



WHEN TO USE SINGLE-ROW RADIAL-THRUST BEARINGS

If your application requires maximum capacity for thrust loads in *one direction only* or *combined radial and thrust loads* with predominant thrust load, specify Federal Ball Bearing Series 7200, 7300 or 7400.

These Federal bearings are so engineered that the angle of contact between the balls and the races will be more nearly in line with the resultant pressure from combined thrust and radial loads than would be the case with single row radial ball bearings. Higher outer ring shoulders on the thrust side and deep, continuous inner ring raceways assure maximum ball contact area. The low outer ring shoulder opposite the thrust face permits the use of the maximum number and size of balls. These features give Federals their consistently high load carrying capacity. The bearings are non-separable after assembly and not adaptable for pure radial loads.

Federal Single-Row Radial-Thrust Bearings are made in light, medium and heavy series to cover a wide range of applications. Our Catalog "K" includes ball bearing selection charts to help you compute bearing loads, determine load ratings for all bearings at all speeds, and select the type and size ball bearing best suited to your application. It also describes these and one of the most complete lines of ball bearings...every type and size...shielded and sealed...for every anti-friction need. (A few of the many types are illustrated above.) Write for your copy today.

THE FEDERAL BEARINGS CO., INC. • POUGHKEEPSIE, NEW YORK

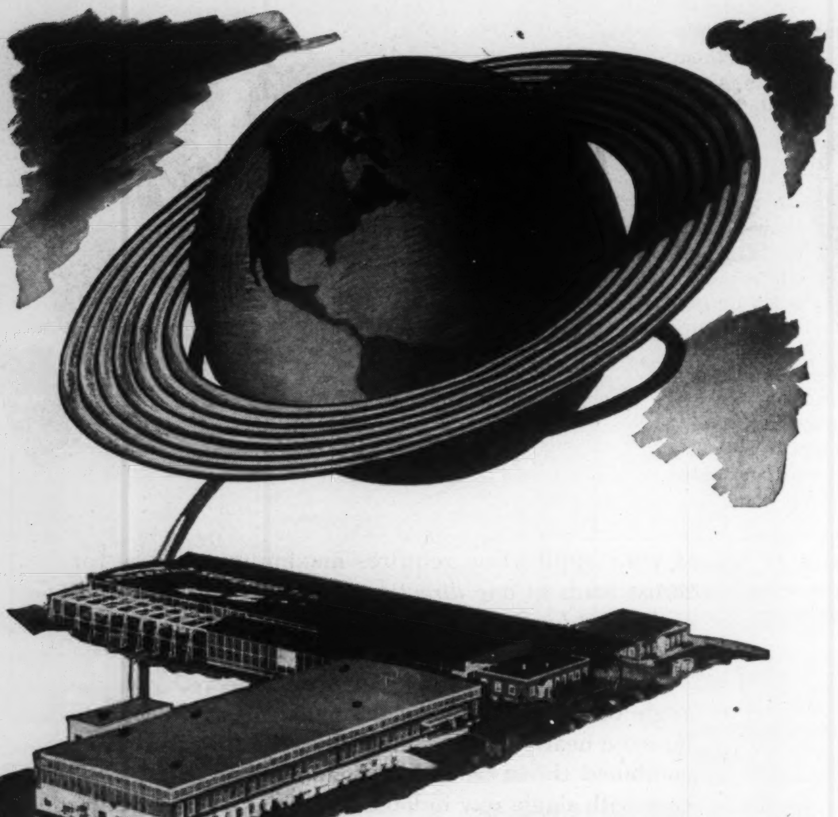
Makers of Fine Ball Bearings

REPRESENTATIVES LOCATED AT
2640 Book Tower, Detroit 26, Michigan • 8 South Michigan Ave., Chicago 3, Illinois
402 Swetland Building, Cleveland 15, Ohio

FEDERAL BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

Quality since 1908



188,000 sq. ft.

***PRODUCING* METAL TUBING**

(.010" TO ⅝" O.D. MAX.)

For the finest small metal tubing, cold drawn to your specifications, you will find *Superior* high quality small tubing (Max. O.D. ⅝") *best* for any application—usual or unusual. To produce High Quality tubing we follow these "rules of production", rules which are the direct result of the years of experience of the men at Superior . . .

- **Control of raw stock—satisfactory composition is assured *before* processing.**
- **Metallurgical control throughout the full production cycle.**
- **Planned cold drawing schedules—to handle large production runs and repeat orders.**
- **Controlled atmosphere annealing between each drawing to assure clean, bright finished tubing.**
- **Visual inspection and laboratory testing of each order to guarantee only tubing that is dimensionally and metallurgically accurate.**

Carefully selected distributors, located in all principal cities in the U. S. and Canada, have qualified representatives who will be glad to discuss your tubing needs.

Do you have a copy of Bulletin #31? We will be glad to send a copy at once.

Superior

THE BIG NAME IN SMALL TUBING (.010" TO ⅝" O.D. MAX.)

SUPERIOR TUBE COMPANY
2010 Germantown Avenue • Norristown, Pa.
For Superior Tubing on the West Coast, call PACIFIC TUBE CO.
5710 Smithway St., Los Angeles 22, Cal. • ANgelus 2-2151

Sales Notes

PRODUCT development department has recently been established by E. F. Houghton & Co., Philadelphia manufacturer of industrial oils, chemicals and leathers. This new department, headed by Dr. H. B. Walker, will facilitate handling and evaluation of new products and bring closer together the research, production and sales staffs.

◆

Ward Leonard Electric Co. has moved its general office from the factory building to 115 South MacQueston Parkway, Mt. Vernon, N. Y. The new general office includes executive and sales offices and the company's headquarters for all operations.

◆

Announcement has been made of the appointment of the Cincinnati Industrial Sales Co., 2832 Stanton Ave., Cincinnati 6, O., as sales representative of the John S. Barnes Corp., Rockford, Ill. The Cincinnati Industrial Sales Co. will supply hydraulic structures, controls and fluid power units to buyers in southern Ohio and southern Indiana.

◆

Aro Sales & Service Inc. has been formed for the distribution of Aro Equipment Corp. products. Headquarters are to be maintained at 2023 South Grand Ave., Los Angeles 7, Calif., the San Francisco office is at 766 Brannan St., and the Pratto Sales Co., 714 Fourth Ave., Seattle, Wash., is distributor for the Pacific Northwest.

◆

Scully-Jones and Co., Chicago, has appointed the G. C. Wood Co., 814 Clark Bldg., Pittsburgh, Pa., as its exclusive representative in the Pittsburgh area. The Wood Co. already represents the Barber-Colman Co. of Rockford, Ill. and the Detroit Broach Co.

◆

Plans have been announced by E. I. du Pont de Nemours & Co. Inc. to build a $2,000,000 finishes research laboratory in Philadelphia. James B. Bullitt, director of the laboratory, said that construction would begin soon, the building to be occupied late in 1950. This building program will provide for Du Pont's expansion and improvement of facilities for research and development in the field of paints, varnishes, enamels, synthetic resins

8 MODERN FOUNDRIES
(Coast-to-Coast Service)

AS-CAST SURFACES that require little finishing

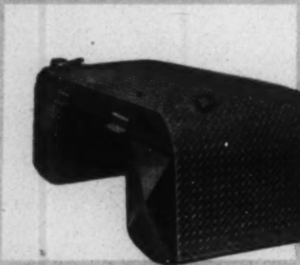
When you figure casting costs, be sure to include the cost of handling and finishing. Alcoa Castings—sand, permanent or semipermanent mold, are held to such close tolerances that minimum machining is required. Result: you get castings that are competitive in cost per *finished piece*—and a big sales plus in aluminum's light weight, attractive appearance.

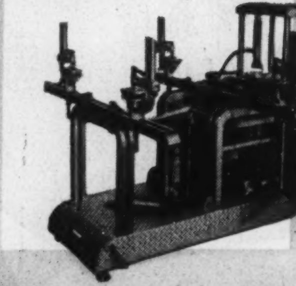
Call your Alcoa representative for more information and a prompt quotation. Or write Aluminum Company of America, 675 Gulf Bldg., Pittsburgh 19, Penna.

Both Sand and Permanent-mold Foundries at each of the following cities: Bridgeport, Conn., Cleveland, Detroit, Los Angeles

ALUMINUM CASTINGS *by* ALCOA

You're Always Safe and Safe ALL Ways On





AW SUPER-DIAMOND FLOOR PLATE
A BETTER FOOTING FOR PRODUCT AND PLANT

Grip Without A Slip!
Easy To Clean!
Easy To Match!

Install AW Super-Diamond Floor Plate in your plant and say goodbye to costly slipping accidents and floor maintenance bills. The exclusive engineered pattern provides maximum skid resistance regardless of how the plate is laid or the angle from which it is approached. More and more architects are specifying AW Super-Diamond Floor Plate, and leading Product Designers are using it for machine tool bases, saddle tanks and similar products on which men walk and climb. For safety's sake specify AW Super-Diamond Floor Plate for your plant and products. Write for more information and 16-page, fact-packed catalog.

AW SUPER-DIAMOND
FLOOR PLATES THAT GRIP

AW SUPER-DIAMOND FLOOR PLATE

FREE—16-Page Catalog L59. Write for your copy now.

A Product of ALAN WOOD STEEL COMPANY
CONSHOHOCKEN, PENNA.

OTHER PRODUCTS: Permaclad, Stainless Clad Steel • AW Super Grip, Abrasive Floor Plate • Billets • Plates • Sheets (Alloy and Special Grades)

and other finishing materials. The laboratory will be available for users of Du Pont finishes who desire to solve production problems or try new finishing recommendations.

◆

Exclusive representatives for Hydro-Line Mfg. Co. are Leaser Engineering Co., LaPorte, Ind., covering the territory of northern Indiana and the south side of Chicago, and Euclid Machine & Sales Co., 1836 Euclid Ave., Cleveland, O., whose territory is northern Ohio.

◆

Dixie Art Supplies Inc., southern distributors of paint specialties of the Craftint Mfg. Co., has moved into larger warehouse and offices at 518 Natchez St., New Orleans, La.

◆

The Leece-Neville Co., Cleveland, has announced plans to expand and improve its facilities for the production of electrical equipment for the automotive, aviation, marine and diesel industries. The addition will be erected adjacent to the plant at 5109 Hamilton Ave., and their building at 5351 Hamilton Ave. will be expanded and used for the design and technical departments and engineering laboratory.

◆

Acquisition of a new modern plant has been announced by the Weldaloy Products Co. of Detroit, Mich. The new plant adjoins the present one and is used to produce special types of resistance welding supplies.

◆

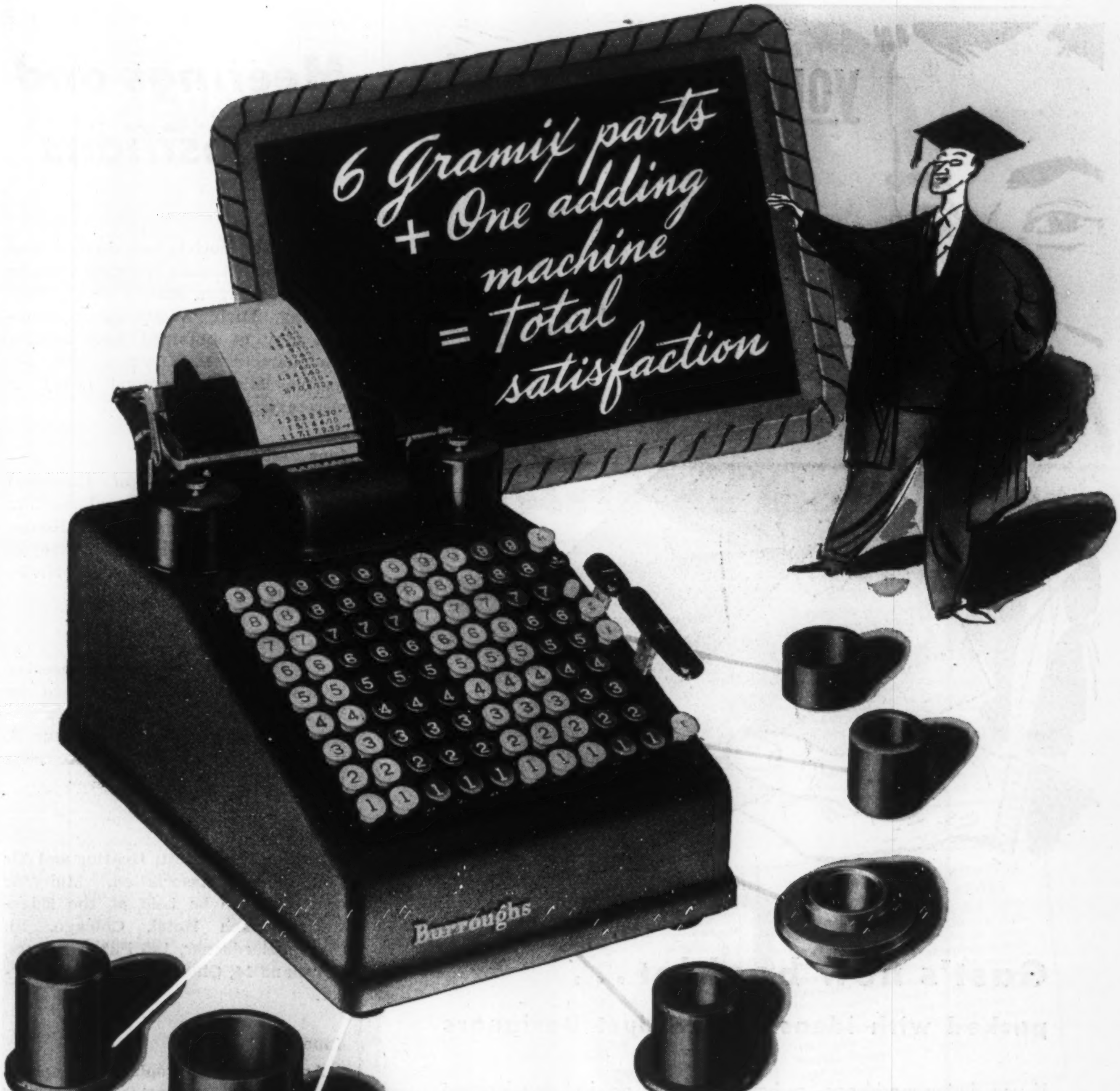
The purchase of a government-owned aluminum extrusion plant at Grand Rapids, Mich., was announced recently by the Reynolds Metals Co. of Louisville, Ky. The plant, designed for the production of high-strength aluminum rod, bar, shapes and tubing is expected to reach peak production in August or September.

◆

Allis-Chalmers Mfg. Co. has purchased WAA warehouse 7 at Carrollville, Wis., to be used temporarily as a warehouse and later converted to general manufacturing.

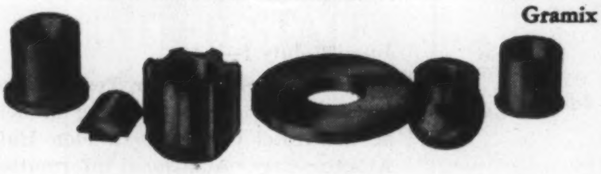
◆

Eastern Missouri and southern Illinois are now served by Young & Myers 539 Jewel Ave., Kirkwood 22, Mo., as sales representatives for the Clarostat Mfg. Co. Inc., manufacturers of resistors, controls and resistance devices.



The almost uncanny efficiency and complete dependability of today's adding machine is a triumph of American ingenuity — and the result of sound engineering and design. The whirling gears and shafts and the lightning-like piston strokes that give accurate totals with amazing speed *are kept true and trouble free* in many of the popular makes, *with the help of Gramix bearings.* In the machine shown, six Gramix powdered-metal bearings — five bronze and one iron — perform faultlessly. Gramix bearings are die-pressed powdered metals that *require no costly machining and finishing.* Gramix parts are porous — retaining lubricant and releasing it only as required. They are tough and strong and operate with a minimum of noise and wear. Gramix gears, bearings, bushings and other machine parts may help you solve a production problem and save you money. Send us your prints for specific recommendations. *Ask for your copy of the 264-page Gramix catalog.*

GRAMIX



THE UNITED STATES GRAPHITE COMPANY • SAGINAW, MICHIGAN

DIVISION OF THE WICKES CORPORATION

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26
PRODUCT PROBLEMS
problem
solution
ORIGINAL EQUIPMENT
APPLICATION IDEAS
FOR PRODUCT ENGINEERS
GAST rotary AIR motors · compressors · vacuum pumps

Gast's new booklet . . .

packed with ideas for Product Designers

If you design machinery—or have a part in product development—you'll find this booklet a useful idea-source. It shows 26 examples of how *air* was put to work to solve product-function problems. And the actual problems solved range from feeding light materials into automatic machinery to simulating manifold vacuum conditions for testing automobile heaters.

In short, you'll find data on the use of air for all sorts of common and uncommon applications.

We believe it's a booklet you'll want to read through—and keep handy. For sooner or later, "Air may be *your* Answer" on one of your product design problems.

Write on your letterhead for a copy of "Application Ideas".

GAST ROTARY
(TO ONE H.P.) (TO 30 LBS.) (TO 28 INCHES)
GAST MANUFACTURING CORP., 107 Hinkley St., Benton Harbor, Mich.

Meetings and Expositions

June 20-23—

American Society of Agricultural Engineers. Annual meeting to be held at Michigan State College, East Lansing, Mich. Additional information may be obtained from society headquarters, P. O. Box 299, St. Joseph, Mich. Raymond Olney is secretary.

June 20-24—

American Institute of Electrical Engineers. Summer general meeting to be held at New Ocean House, Swampscott, Mass. H. H. Henline, 33 West 39th St., New York 18, N. Y., is secretary.

June 20-24—

American Society for Engineering Education. Annual meeting to be held at Rennselaer Polytechnic Institute, Troy, N. Y. Prof. Arthur B. Bronwell, Northwestern University, Evanston, Ill., is secretary.

June 21-22—

National Warm Air Heating and Air Conditioning Association. Mid-year convention to be held at the Edgewater Beach Hotel, Chicago, Ill. George Boeddener, 145 Public Square, Cleveland 14, Ohio, is managing director.

June 27-30—

American Electroplaters' Society. 36th annual convention to be held at the Hotel Schroeder, Milwaukee, Wis. Additional information may be obtained from the national offices at 473 York Rd., Jenkintown, Pa.

June 27-30—

American Society of Mechanical Engineers. Semiannual meeting to be held at the University of California, Extension Building, San Francisco, Calif. C. E. Davies, 29 West 39th St., New York 17, N. Y., is secretary.

June 27-July 1—

American Society for Testing Materials. 52nd annual meeting to held at the Hotel Chalfonte-Haddon Hall, Atlantic City. Additional information may be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa. Robert J. Painter is assistant to the secretary.

More OEM's* Specify US Gauge Than Any Other Make!

* Original Equipment Manufacturers

. . . Because USG Assures More Value

Throughout industry, the story is the same from year to year. Original equipment manufacturers (OEM's) demand substantial gauge value . . . accuracy, durability, and quality at economy prices . . . and 6 out of 10 specify US Gauges.

They know that US Instruments give more service, more accuracy, more *value* for the money. They know USG can supply all their needs—from highly specialized instruments measuring as low as 1" of mercury absolute, to standard type gauges measuring from 30" vacuum to 100,000 pounds pressure per square inch. And they know that for more than 40 years US Gauges have been the standard of dependability. So more original equipment manufacturers specify US Gauges than any other make.

Next time you order gauges, follow the lead of these satisfied users . . . buy US Gauges. For more information about US Gauge write today. United States Gauge, Division of American Machine and Metals, Inc., Sellersville, Penna.

US GAUGES—BETTER INSIDE . . . BETTER OUTSIDE . . . BETTER ON YOUR PRODUCT

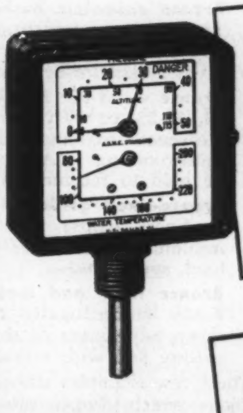
USG

UNITED STATES GAUGE

100
200
300
400
500
600

TURRET CASE GAUGES

A complete line of bakelite turret case gauges conforming to current U. S. Navy specifications. For general use in refinery, chemical or power plants. Bourdon tube of phosphor bronze or stainless steel conforming to Navy types A or B. Movement of corrosion resistant bronze and nickel silver construction. Socket, spring, movement and dial are an integral unit removable from case for testing. Micrometer adjustable pointer, separate adjustable red hand. Accuracy ½ of 1% for middle third of scale and 1½% maximum scale range of balance. Ranges up to 5000 P.S.I.



COMBINATION THERMOMETER AND ALTITUDE GAUGES

For installation on domestic hot water heating systems. Indicates on one dial: water temperature, altitude of water above gauge. Wide phosphor bronze Bourdon tube. All brass heavy-duty movement. Temperature indicating section of spiral bimetal strip connected to stainless steel shaft operating in phosphor bronze bearing. Heavy pressed steel case with low or back male connection. Ranges 60° to 260°F. 0 to 115 feet of water.

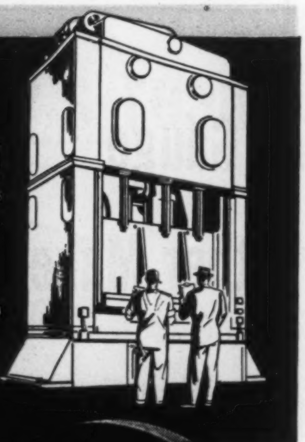
DUPLEX GAUGES

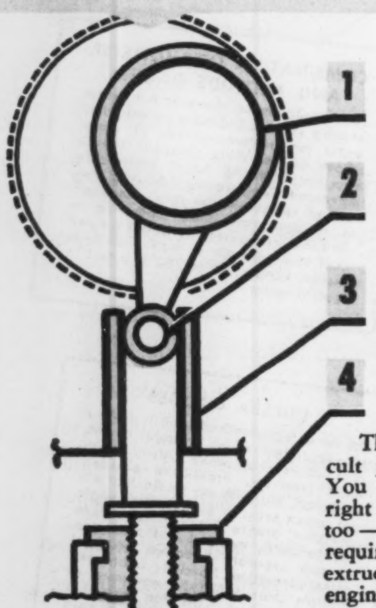
For use on equipment where it is desired to indicate two related pressures on one dial such as in: air brake systems, pneumatic receivers, differential pressure indicators, etc., with any media that will not attack brass or bronze. Two single phosphor bronze Bourdon tubes are independently mounted and connected to two separate threaded external socket connections. Specially constructed multiple plate quill type movement of brass throughout. Cast iron case, but available in a number of special case designs for close mounting. Lower or low back side-by-side connections. Accuracy 2% of scale range. Ranges up to 1000 P.S.I.

PRODUCTS OF UNITED STATES GAUGE... Absolute Pressure Gauges • Aircraft Instruments • Air Volume Controls • Altitude Gauges • Boiler Gauges • Chemical Gauges • Dial Thermometers • Glass Tube Thermometers • Flow Meters • Inspectors' Test Gauges • Laboratory Standard Test Gauges • Marine, Ship and Air-Brake Gauges • Recorders • Controls and Alarm Gauges • Voltmeters • Ammeters • Welding Gauges

U.S. INSTRUMENTS Tell The Truth

USG





AMPCO Metal can really take it!

Exceptional strength . . . high fatigue limits . . . wear resistance and resistance to impact

—just the material for your tough jobs!

Possibly you don't make or use heavy presses. But probably you *do* have jobs for Ampco Metal — tough jobs where you need the same superior performance that Ampco Metal gives in these press applications.

***Ampco 24 Extrusion Punch Outlasts the Best Steel 10 to 1**

The extrusion punch at the right extrudes a 5/8" hole to a 3¼" diameter in a heavy gauge steel water heater head. The best steel punches produced 6600 pieces *maximum*. With the new Ampco Grade 24 punches, production runs of 65,000 pieces became *average* on this job.

Ampco Bronze in the Press itself!

1 **Bronze eccentric bushings** — Ampco Grade 12 Bushings, centrifugally cast, provide a wear-resistant eccentric bearing lining that gives maximum heavy-duty service.

2 **Bronze wrist-pin bushings** — Ampco Grades 18, 18-23, or 20 centrifugally cast bushings withstand extremely heavy loads without mushrooming. (Ampco field engineers will be glad to recommend proper grade.)

3 **Bronze-lined guides** — Ampco 8 Sheet used as liners (gibs) give maximum life with minimum wear under varying conditions of load, speed, etc.

4 **Bronze liner and locking nut** — Ampcoloy E-123 (centrifugally cast) affords up and down adjustment of shutting height without galling and with minimum wear.

These few examples illustrate some of the difficult jobs which Ampco alloys handle with ease. You can select a grade of Ampco Bronze that is right for your production and maintenance needs too — produced by the method best suited to your requirements: sand or centrifugal castings, sheet, extruded rod, etc. See your nearby Ampco Field engineer for specific recommendations.

AMPCO METAL, INC.
MILWAUKEE 4, WISCONSIN
West of the Rockies it's the Ampco Burbank Plant, Burbank, Calif.

AMPCO ®

Tear out this coupon and mail today!

FREE Cost-cutting information on dependable Ampco Bronze Alloys!

AMPCO METAL, INC., Dept. MD-6, Milwaukee 4, Wis.
Send me FREE literature giving complete information regarding Ampco Metal and Ampco Bronze Alloys!

Name...Position.................................
Company...
Address...
City...( ) State...........................

Design Abstracts

What Good Are Standards?

IT IS NOT A matter of inquiring what good are standards in connection with the purchasing function but, rather, the question of how to operate without them. It is not often realized that pricing is a fluctuating yardstick depending largely on quantity *and* quality. There must be some standard of measurement if any intelligent decision is made between sources and products. Accordingly, we begin with the conviction that standards in the procurement of manufacturing materials are vital to an efficient operation.

Purchasing activity has gone on for hundreds of years, but only recently, with the development of large-scale mass production and an increasingly complex industrial life, has purchasing become recognized as an important cog in commercial life. This led to the use of scientific methods and specialized skills to meet the responsibility. Today, through the use of standards, the purchasing agent conveys to his supplier of raw materials, semiprocessed goods or finished components, an exact understanding of what is required, the terms of exchange and conditions upon which the material will be accepted or rejected. This simplifies the problem of procurement. The use of standards makes possible a satisfactory competitive situation conducive to close pricing, rigid quality control, product dependability, and good customer service. Then the buyer can place business with confidence in his merchandise and with minimum inspection and testing.

Standards Simplify Purchasing

National and international standardization sponsored by trade and technical associations through the facilities of ASA goes far in providing the foundation on which the purchasing department can operate. Volume is created in many staple items and advance stock buying can be practiced. A company which operates without standardization is one which will never be competitive and therefore leads itself to early liquidation.

The advantages to a company which makes good use of standards are numerous; for example:

INVENTORIES: A minimum inventory expense results. Inspection is

We give you
A STRAIGHT
ANSWER

Here at Moraine Products we have a realistic attitude towards powder metallurgy. We know its advantages thoroughly—and we know its limitations just as well.

So, when we recommend metal powder for parts production, we recommend it *without reservation.* We make certain beforehand that we have the most satisfactory process for your needs—or we don't accept your order.

Our broad manufacturing experience has taught us that powder metallurgy is practical only when parts fulfill three conditions:

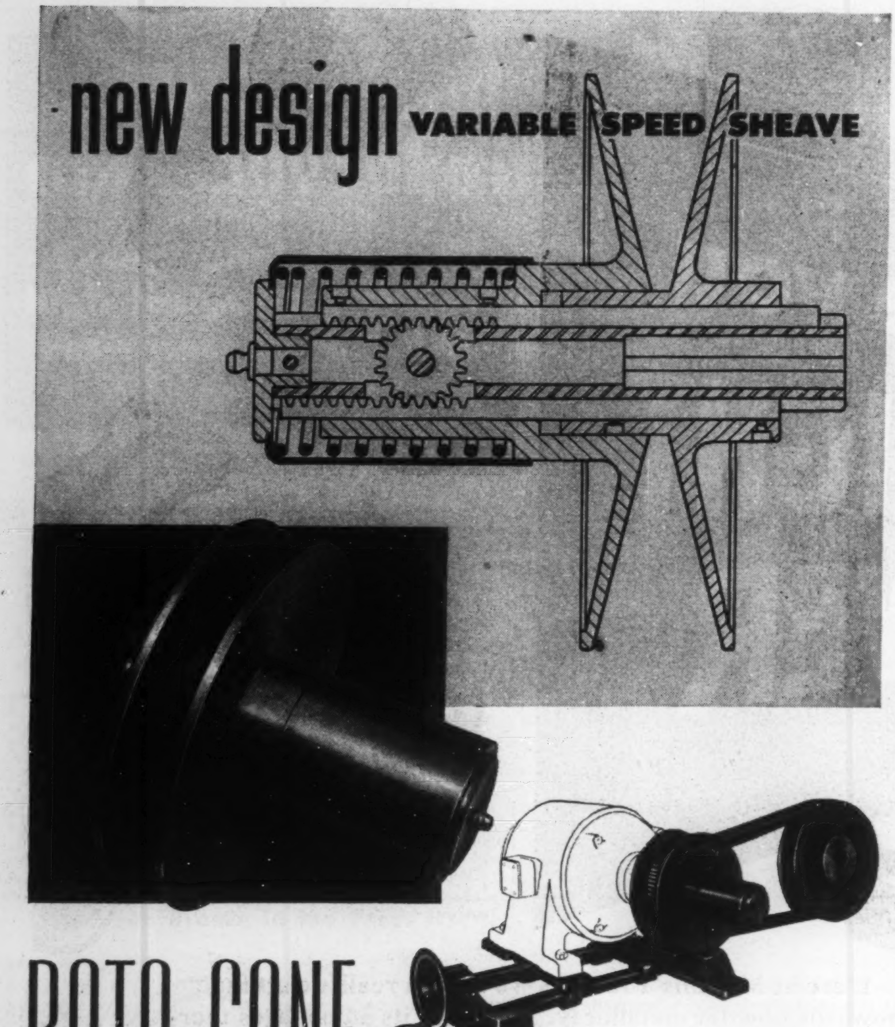
1. The shape must permit good die fill and proper density.
2. The order must be sufficiently large to justify tooling costs.
3. The physical properties and tolerances required must be within the range attainable in normal factory production.

In other words, we analyze your requirements. And when we accept your order, it's because we can produce a product that will give you lasting satisfaction.

**METAL POWDER PARTS
BY MORAINE**

MORAINE PRODUCTS

DIVISION OF GENERAL MOTORS, DAYTON, OHIO



ROTO-CONE

constant belt centerline, true V to V

Double rack and pinion provides equal movement of both sheave faces on the ROTO-CONE. That means a constant belt centerline and full power with a V-groove driven sheave. Belt life is lengthened ... torque load, noise and vibration are eliminated. No shaft extension or countershaft required. The ROTO-CONE is ideally suited to vertical or horizontal mountings with sizes available to meet horsepower requirements from ⅛ to 7½.

ROTO-CONE drives include variable speed sheaves, V-groove driven sheaves, wide V-belts and adjustable motor bases . . . all engineered for lowest cost speed control. All sizes available from stock. Write or call today for details and the assistance of qualified engineers in selecting the ROTO-CONE drive to fit your equipment.

ROTO-CONE
complete
VARIABLE
SPEED
DRIVES

GERBING MANUFACTURING CORP.
650-A West Washington Blvd., Chicago 6, Illinois

simplified and disagreements concerning quality and interpretation of the article ordered are held to a minimum. The handling of materials is a minor problem when an article is standard instead of in numerous variations.

COST: Special setups for the use in production of small quantities of varying items result in major costs. These are eliminated through close adherence to standard commercial specifications in procuring necessary materials.

AVAILABILITY: When purchasing common standard items the supporting of production lines is simple. The scheduling of deliveries and drawing from inventory stock is reduced to a clerical function. By using standard articles, materials are also available from numerous concerns instead of just one.

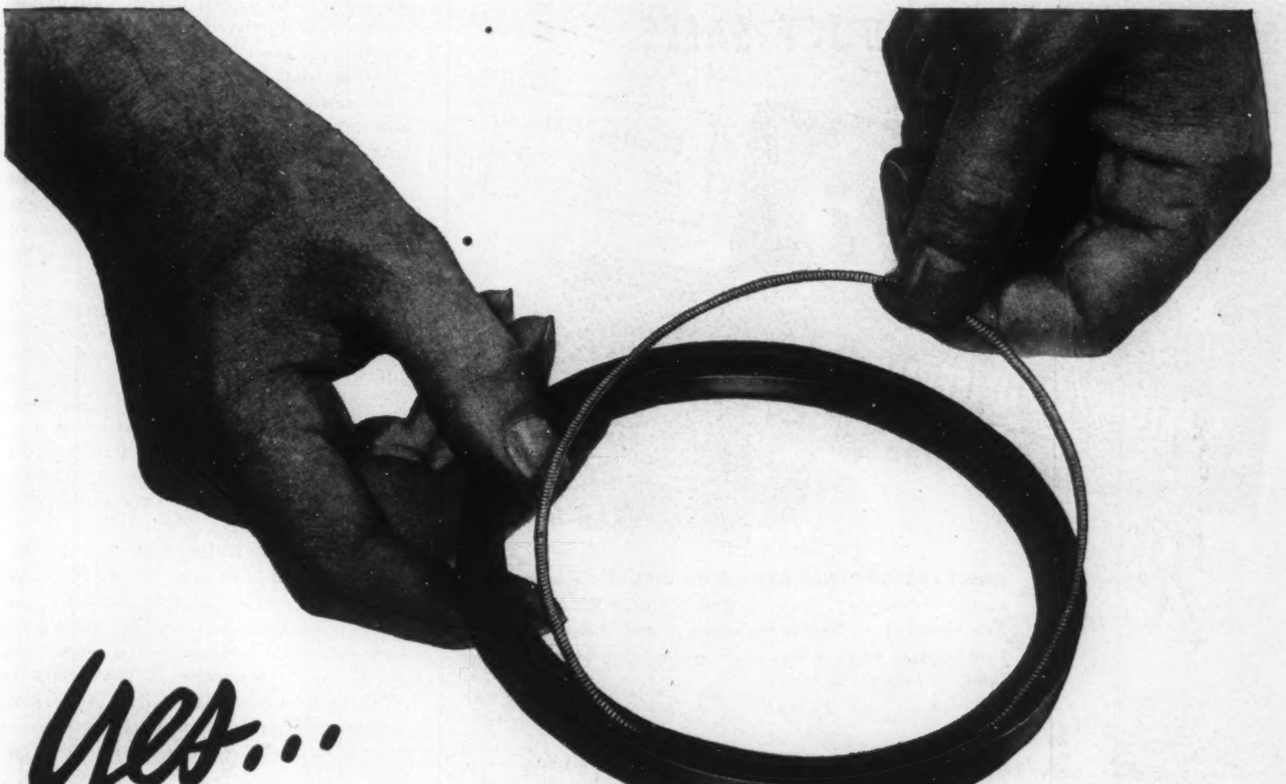
COST OF ENGINEERING FUNCTION: The preparation and use of voluminous drawings for special items, necessitate extensive work by engineering personnel and increase the cost of a product. Standardization keeps this to a minimum. *From a paper by V. de P. Goubeau, director of materials, RCA Victor Div., Radio Corp. of America, presented at the recent annual meeting of ASA in New York.*

Brazed-Joint Strengths

IN a tension test, the performance of a single piece of metal and of a brazed specimen may differ basically. The assembly is comprised of the two components which are joined, the layer of brazing alloy and the interfaces. Strength of the assembly depends not only on the properties of the individual elements, but also upon the mechanical restraints that the harder elements of the assembly may exert upon the softer ones. The tensile strength of butt joints brazed with silver alloys is influenced by the following:

1. Degree to which the materials being joined are wetted by and bonded to the brazing alloy
2. Thickness of the brazing alloy layer in the joint itself
3. Strength of metal or metals being joined
4. Amount of flux inclusions or voids in the joint
5. Mechanical characteristics of the structure.

The strength of the brazing alloy itself, which is approximately 70,000 psi, is of significance only in that when materials weaker than this are joined, tension failure usually will occur outside the joint. In stronger materials failure occurs in the joint



yes... an oil seal that's tailor-made to *resist* corrosion

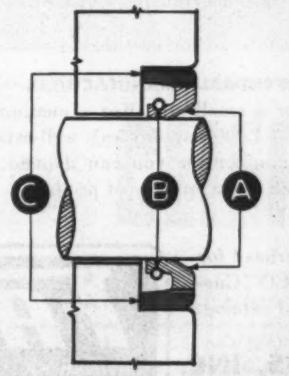
• If corrosive conditions are shortening the life of your oil seals, the Johns-Manville Clipper Seal should provide a practical solution to your problem.

Here's why: The Clipper Seal's molded body is entirely non-metallic and is, therefore, unaffected by most forms of corrosion. To meet special conditions, the garter spring which holds the lip in contact with the shaft can be furnished in various corrosion-resistant metals . . . *or Clipper Seals of special design that do not require garter springs may be used.*

The one-piece, concentric molded design of Clipper Seals also assures a number of other advantages. The hard, tough outer heel of the Clipper Seal is resilient enough to conform even to a slightly out-of-round cavity. And the soft, pliable inner lip always maintains a light, but positive sealing pressure on the shaft, with minimum wear on the seal.

Clipper Seals are quick and easy to install, may be had in split or endless types, are available in sizes from ¼″ I.D. up to 66″ O.D. If you have a special sealing requirement, or wish to consult about a special design problem, write Johns-Manville, Box 290, New York 16, N. Y.

Here's how *Clipper Seal* works:



The flexible lip (A) is held in light but firm contact with the shaft by means of the garter spring (B). Pressure on shaft is carefully pre-determined to minimize wear, yet effectively seal against leakage. The rigid heel (C) provides a press fit in the cavity, assuring a tight lubricant-retaining seal at this point also.

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EFFICIENT PERFORMANCE—So important to the success of *your* product . . . proved by FASCO'S continuing success and growth . . . attained by building the maximum in quiet, economical, trouble-free operation into motors for many thousands of products that have served users with full satisfaction.

FASCO QUALITY—Adds an extra measure of value to your product. Every step in the manufacture of FASCO Motors . . . from raw stock to final test . . . is under rigid uniform control of the most precise instruments and methods.

DEPENDABLE MANUFACTURER—Not a giant plant, nor a small one. But a medium-size (250,000 sq. ft.—1,000 employees) well-established reputable manufacturer you can depend on for *delivery* as well as for quality of product.

WRITE on your company letterhead for complete information on FASCO "Custom Engineering Service," and catalog.

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FRACTIONAL H.P. SHADED POLE 1/500 to 1/8 H.P.
MOTORS and BLOWERS

at loads which are greatly in excess of the strength of the brazing alloy itself.

Most metals, when properly fluxed, are readily wetted and bonded by low-temperature silver brazing alloys and the bond strength will be greater than the strength of the brazing alloy itself. In certain cases, particularly in alloys containing aluminum, special fluxes are required to achieve this wetting.

Copper and brass rods, butt brazed, may be drawn down to fine wire. Plates having a cladding of other metal brazed to the face may be rolled into thin sheets. T or L-joints in plates or sheets of ductile material can be hammered flat without breaking. Sheet products having brazed seams have been formed, drawn and beaded.

Where joint failures in ductile materials occur because of stress concentration, the failures usually involve the tearing out of pieces of the metal joined. *From a paper by A. M. Setapen and C. D. Coxe, Handy & Harman Co., presented at American Welding Society technical session of Western Metal Congress in Los Angeles.*

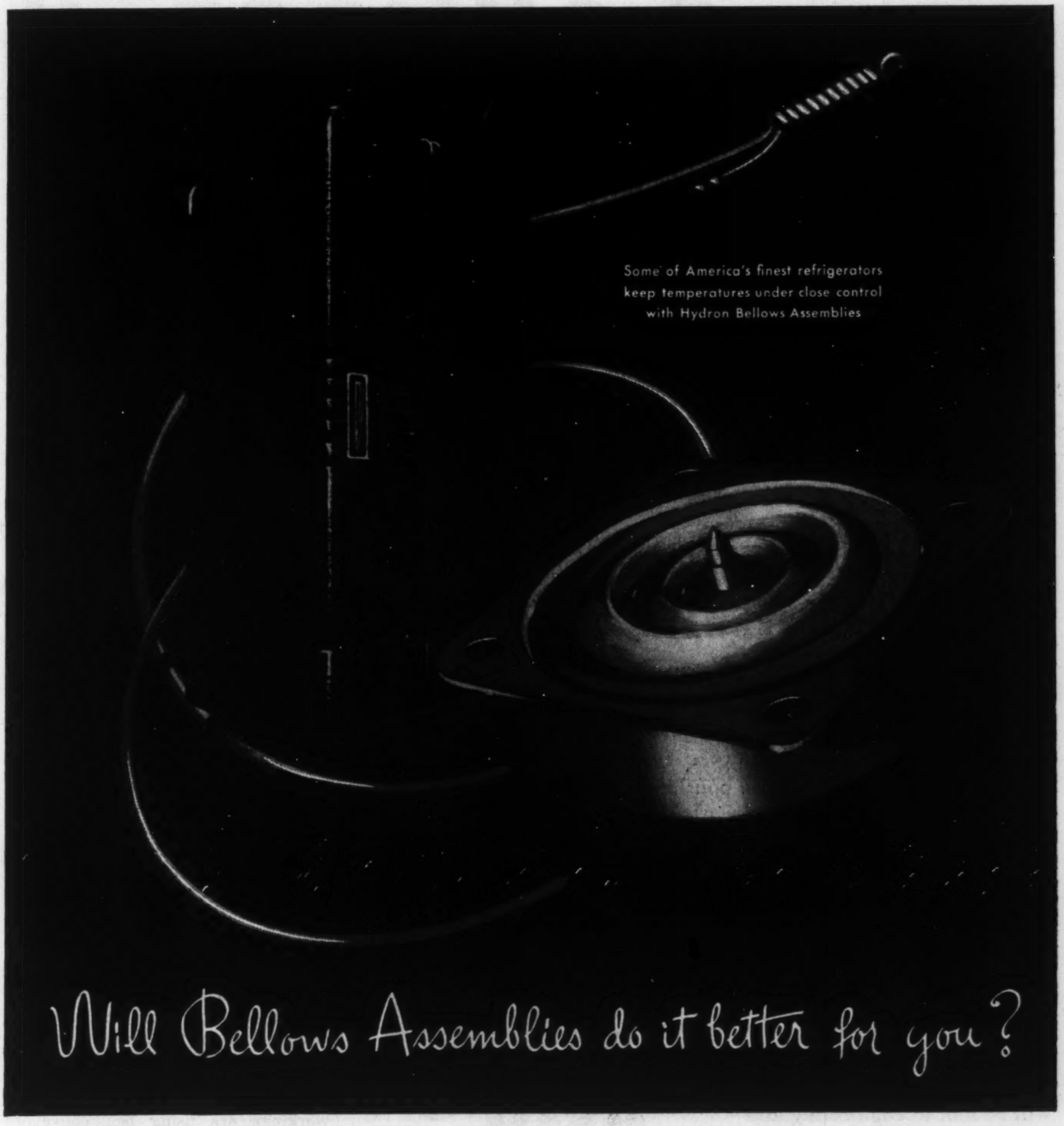
Mining Conveyorization

TODAY approximately 97 per cent of total bituminous production is mechanically mined and about 60 per cent mechanically loaded. While mechanization in the American coal mines has progressed far beyond that in other countries, only a beginning has been made.

The ideal, low-cost situation would be a continuous flow. There are many problems that have not yet been solved, however. It is toward that goal that the coal industry is working. "Continuous miners," machines which combine cutting and loading, are now undergoing tests.

Continuous mining, however, can be only as continuous as the transportation system that carries the coal from the working face to the surface. The belt conveyor is actually the only continuous system. Today it is only the belt conveyor that will handle the movement of coal without the stop-and-go characteristic of other systems. When you have a machine designed to turn out up to five tons of coal per minute from the face of the working, like the new experimental continuous miners, you must have a heavy-duty transportation system to support that production. If you have not, many of the advantages of the continuous cutting and loading machine quickly are lost.

At this point, someone could well ask why there is any question about



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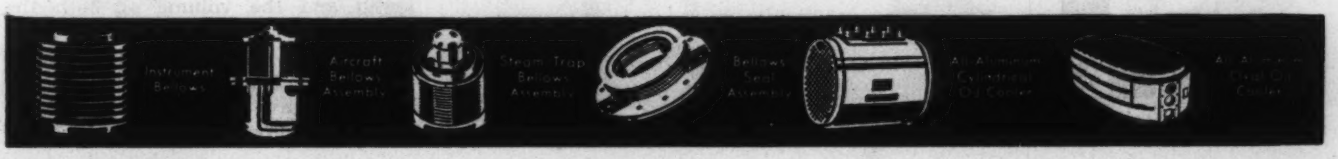
ALL-ALUMINUM OIL COOLERS FOR AIRCRAFT ENGINES



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Hoover Ball Bearings provide greater load capacity — longer life . . . plus values made possible by honed raceways, an exclusive Hoover feature. For Hoover honing goes a step beyond grinding and polishing in producing finer, smoother raceway surfaces. Closer race curvatures furnish a wider area of ball support for greater work . . . greater bearing surface for extended life. Thousands of manufacturers of quality products have gained a competitive advantage in their markets by using Hoover Ball Bearings with honed raceways. Upon request, a copy of the the Hoover Engineering Manual will be sent to engineering and purchasing executives.

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whether to use conveyors or something else. Under almost all conditions, belt conveyors have advantages not held by other systems. But the problem isn't really as simple as that. Nearly all the older mines have enormous investments in trackage and cars. It is obviously not practical to junk all that and start over. In such mines, the use of conveyors is confined more or less to the working of new faces, with conveyors loading into cars.

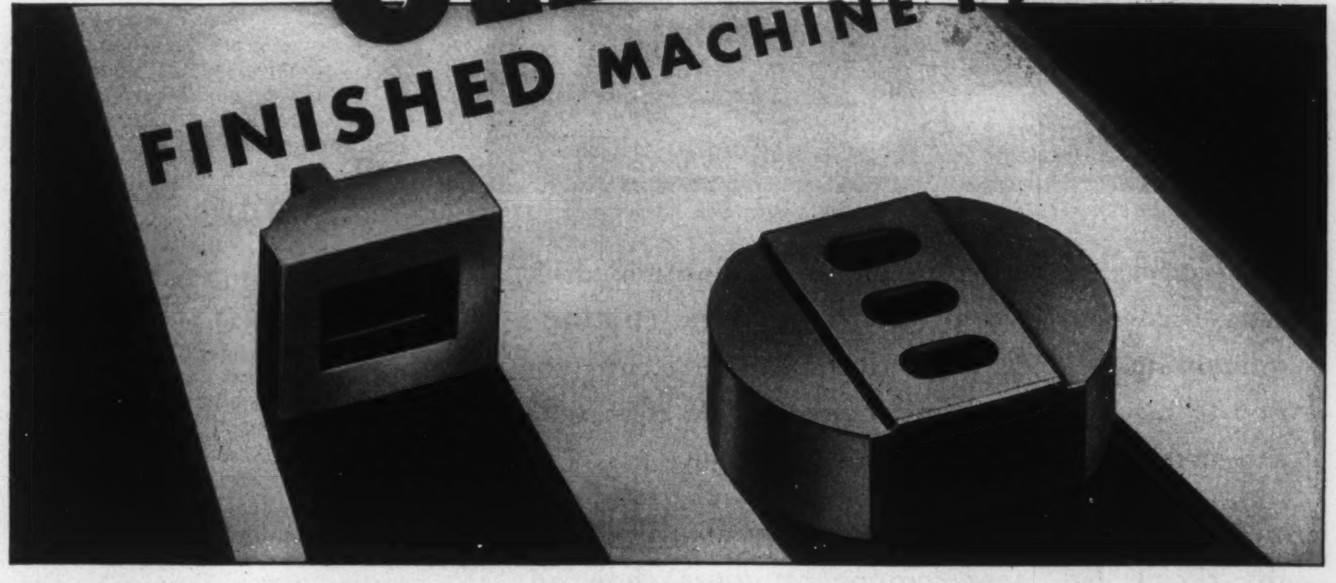
In some of the older mines, however, conveyorization has helped operations maintain a competitive position. In new underground mines the situation is quite different. In these mines, conveyorization is as close to 100 per cent as it is now possible to get. Brand new mines, being opened in the bituminous fields, are making the fullest use of conveyors. As a result of complete mechanization, one mine in Illinois has increased its production to 32 tons per man day, five times our national average, and almost 25 times the average production in England.

Opportunities in Strip Mining

Strip mining brings with it challenging new problems in transporting bulk materials, not the least of which is the huge quantities of materials to be handled. For instance, there is one mine in West Virginia where the problem is one of moving 30,000,000 tons of over-burden before all the coal can be recovered. This one mine is more than 15 miles long and from one to one-and-a-half miles wide. First the operator must strip off the unwanted material that covers the coal or ore and put it somewhere out of the way of future expansion and operations. In strip coal mining, most of the transportation of over-burden and coal is being carried out by the more mobile motor truck instead of by rail. While newly opened workings are using belt conveyors where possible, certain problems remain to be overcome in completely conveyorizing strip mining operations. You get some idea of the problem when it is realized that the present day excavating bucket can pick up as much as 40 cubic yards of material in one bite—enough to fill a good-sized garage.

The nub of the problem here, as it is in underground coal mining, is to develop a continuous flow of operation through synchronizing the speed and the volume of both the digging and conveying mechanism. To achieve continuous flow from digging to dumping in strip mining we must have bigger rock crushers, mobile feeding ends or extendable

No TOOLING Program with OILITE FINISHED MACHINE PARTS



Finished to Precision Tolerances—No Machining

Eliminating tooling programs will save capital investment, time, floor space, and expense.
With OILITE, Engineers and manufacturers enjoy a NEW freedom of design.
Parts impossible to machine economically can often be made readily, by OILITE powder metallurgy.
OILITE Machine Parts are applicable to mass production.
Note the depression and elliptical bores in the parts shown above.

ADDITIONAL ADVANTAGES OF OILITE METAL POWDER UNITS ARE:

- ★ Quicker delivery.
- ★ No material shortages.
- ★ Every part an engineered product.
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- ★ Metallurgically and structurally homogeneous.
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FIELD ENGINEERS AND SUPPLY DEPOTS IN PRINCIPAL CITIES

GREER ACCUMULATOR REDUCES WORK SPOILAGE BY 24½%

TYPICAL FLASH WELDER USING GREER HYDRAULIC ACCUMULATORS

Photo Courtesy of THE FEDERAL MACHINE & WELDER CO., WARREN, OHIO, U. S. A.

A leading manufacturer of large diameter drills was faced with a problem of work spoilage amounting to 25% of production. This scrap was due to insufficient oil under pressure to cope with the upset requirements of the welder used.

A 2½ gallon Greer Accumulator was installed in the circuit. No other components were changed. Immediately the work spoilage was reduced to ½ of 1%.

This is but one of numerous applications where Greer Accumulators are reducing operating cost, increasing production and improving efficiency of processes and machines.

United States Patents Under Olear Licenses

Sizes from 2 cu. in. to 10 gals., pressures up to 3000 psi.

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HYDRAULICS INC.
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belt conveyors and continuous diggers. Some of these devices are now being tested. We will have all of them within a few years. *From a paper by Harold Von Thaden, Vice Pres. and General Mgr., Robins Engrg. Div., Hewitt-Robins, Inc., presented at the Fourth Annual Time Study and Methods Conference in New York.*

Today's Leaf Springs

THE leaf spring has been criticized not only for being too heavy, but also for excessive interleaf friction. This can hardly be called a problem in the present-day rear springs of passenger automobiles, for they are either equipped with metal spring covers, loaded with lubricant, or else there are liners of wax-impregnated paper or cloth between the leaves, or special fabric, plastic, rubber, or metal alloy inserts at the leaf ends. It is probably not an exaggeration to state that we now have "controlled" interleaf friction in our passenger car leaf springs, which is actually beneficial in that it dissipates some of the energy that otherwise would have to be taken care of by the shock absorber.

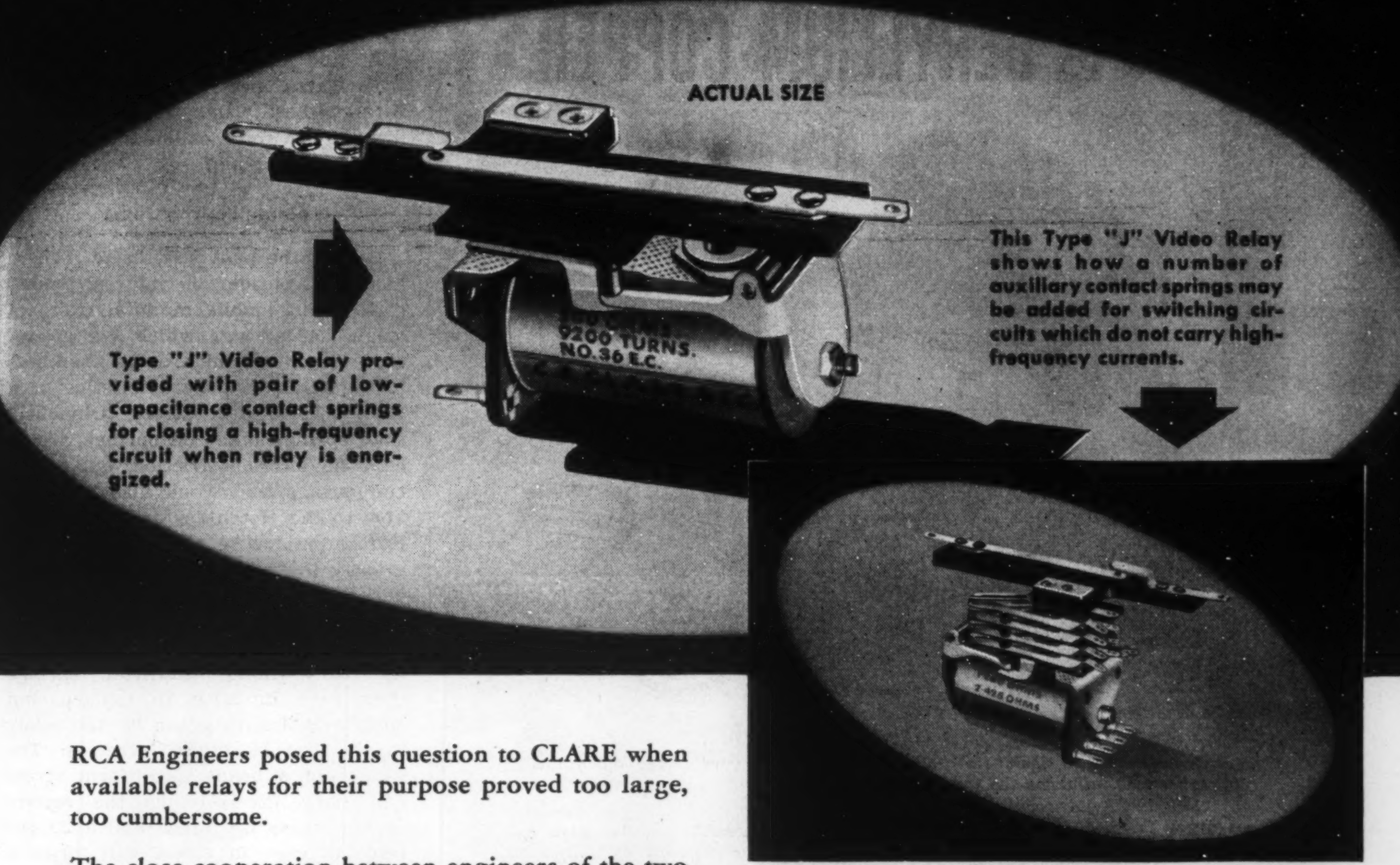
The benefits of varying spring flexibility to meet changes in load are of course obvious, and in the leaf spring we can obtain such benefits without additional cost by taking advantage of the effects of shackle angle. Quoting from Page 57 of the SAE Manual on Design and Application of Leaf Springs:

> "The rate of a spring with shackle depends on the 'nominal' rate of the spring, the position of the shackle, the length of the shackle, the camber of the spring, and the load on the spring."

Three of these factors are usually overlooked, namely, shackle position, shackle length, and spring camber. Pages 58 and 59 of the Manual give curves of the effect of shackle angles on spring rates, which are quite fascinating in their possibilities. For example, Page 58 shows that with a *compression* shackle, the rate can vary from 90 per cent to 195 per cent of the nominal rate at different camber positions. That is, a spring with a nominal stiffness (tested on rollers) of 1000 pounds per inch, can give us 900 pounds per inch rate at light load, increasing to 1950 pounds per inch at overload conditions.

The curves on Page 59 are even more intriguing to the leaf spring user, for they indicate that with a *tension* shackle, the rate can be varied from 63 per cent to 225 per cent

How Big does a Video Relay have to be?



Type "J" Video Relay provided with pair of low-capacitance contact springs for closing a high-frequency circuit when relay is energized.

This Type "J" Video Relay shows how a number of auxiliary contact springs may be added for switching circuits which do not carry high-frequency currents.

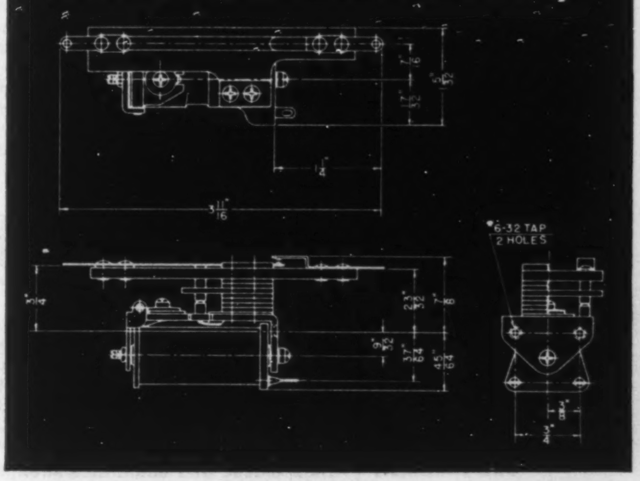
RCA Engineers posed this question to CLARE when available relays for their purpose proved too large, too cumbersome.

The close cooperation between engineers of the two companies which resulted has produced the CLARE Type "J" Video Relay, which meets every requirement for switching these high-frequency currents . . . and occupies but 7 cubic inches.

Success of this cooperation between RCA and CLARE engineers in developing a superior small-size, low-capacitance relay is not only important to this, the world's largest manufacturer of radio and television equipment, but it is of vital interest to every television engineer whose designs are often frustrated by the 17 cubic inches that other typical video relays require.

Clare sales engineers are located in principal cities. They will be glad to give you full information on this new video relay. Their counsel and advice may help you solve other relay problems. More and more, industrial designers bring their problems to Clare, whose long experience in meeting and solving them can save you many hours of tedious and costly experiment. Call your nearest CLARE sales engineer, or write to: C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois.

Dimensions of CLARE Video Relay



Capacitance of CLARE Video Relay

Tests show that this new CLARE relay with a contact gap of 0.025" has the following capacitances:

Interspring Capacitance, Contact Open

0.5 mmf. at 3 megacycles
0.5 mmf. at 10 megacycles
0.55 mmf. at 20 megacycles

Spring-to-Frame Capacitance, Contact Closed

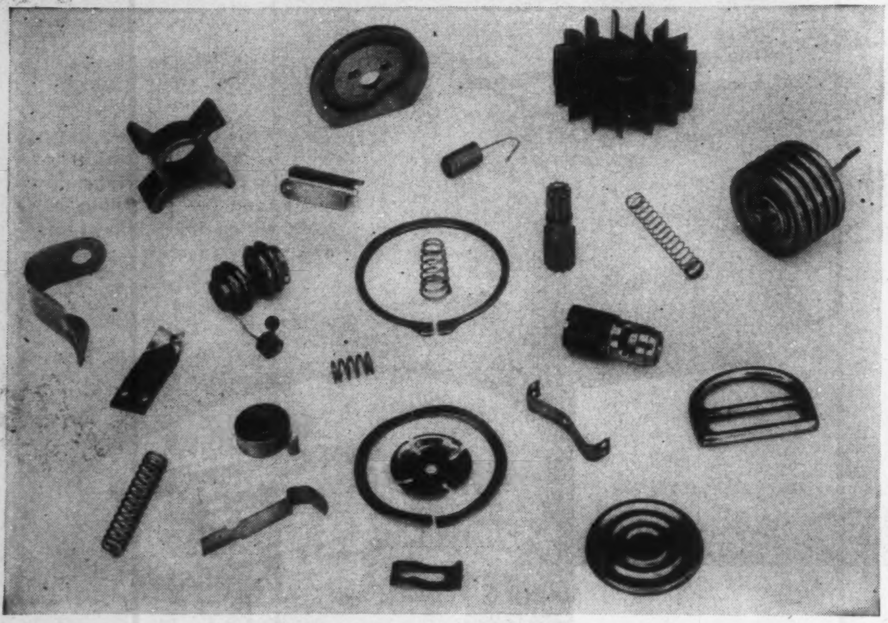
1.4 mmf. at 3 megacycles
1.45 mmf. at 10 megacycles
1.8 mmf. at 20 megacycles

Write for Clare BULLETIN 106

CLARE RELAYS

First in the Industrial Field

For **LOWEST COST**
Where Performance Counts—
Look to **BERYLLIUM-COPPER**



Dollar-conscious designers are saving money by considering the following factors which influence the over-all cost picture.

- **DESIGN** — Beryllium-copper's high strength makes possible smaller parts and lighter sections. This means important cost savings through smaller units, increased sensitivity and added flexibility of design.
- **FABRICATION** — Through heat-treatment beryllium-copper offers economies in fabricating severely formed parts requiring good strength. Parts are readily machined or formed in the unhardened condition, then hardened to maximum properties by a simple, low-temperature heat-treatment followed by uncontrolled cooling. For example, annealed BERYLCO 25S strip withstands the severest forming and reaches an ultimate tensile strength of 175,000 psi after heating for three hours at 600°F. Where less forming is required, cold-rolled tempers give correspondingly higher tensile values. Also, absence of grain direction in moderately cold-worked strip permits efficient use of stock.
- **INSPECTION AND ASSEMBLY** — Uniformity of parts over large production runs reduces rejects and inspection costs, permitting spot checking instead of 100% inspection. Where necessary, fixture hardening insures dimensional control to a degree not otherwise obtainable and eliminates expensive hand adjustment during assembly.
- **MAINTENANCE** — Positive action as measured by resistance to relaxation and drift offers savings through less frequent calibration and reduced labor charges. These features are of particular significance in contacts, diaphragms and instrument springs. The stability of beryllium-copper prevents loss of tension in electrical contact springs, the cause of frequent adjustment in the field.
- **REPLACEMENT** — High elastic and endurance strength, together with excelle resistance to corrosion and wear, means longer life with increased efficiency through fewer breakdowns, preventing disruption of vital services. In addition, part failure may lead to replacement expense many times greater than the expected saving through specifying a cheaper material. This is particularly true for cams, springs, bushings and similar inconspicuous parts on whose faithful service depends the continuous operation of complex machinery. In such applications, beryllium-copper frequently offers the lowest cost answer.

Write today for literature, or if you have a design problem send us full information with a drawing or sample of the part.

The BERYLLIUM CORPORATION
Dept. 5, Reading 1, Pa.

of the nominal rate. Thus, our spring of 1000 pounds per inch nominal rate can give 630 pounds per inch at light load, increasing to 2250 pounds per inch at overload conditions. What is even more surprising, we can have these rate variations without extra cost, and no multistage springs or other extra mechanisms are needed. In fact, these principles are functioning daily in some of our modern passenger automobiles.

Single-Leaf Springs

During the past year or two, there has been considerable interest among certain automobile manufacturers in single-leaf springs which are graduated either in width or in thickness to approach the characteristics of a beam of uniform stress. Obviously such springs, like coil springs, would have no interleaf friction, but unlike coil springs, they would also be adaptable to the Hotchkiss drive principle. Further, sidewise stability might be greatly improved, especially in those where the beam varies in width.

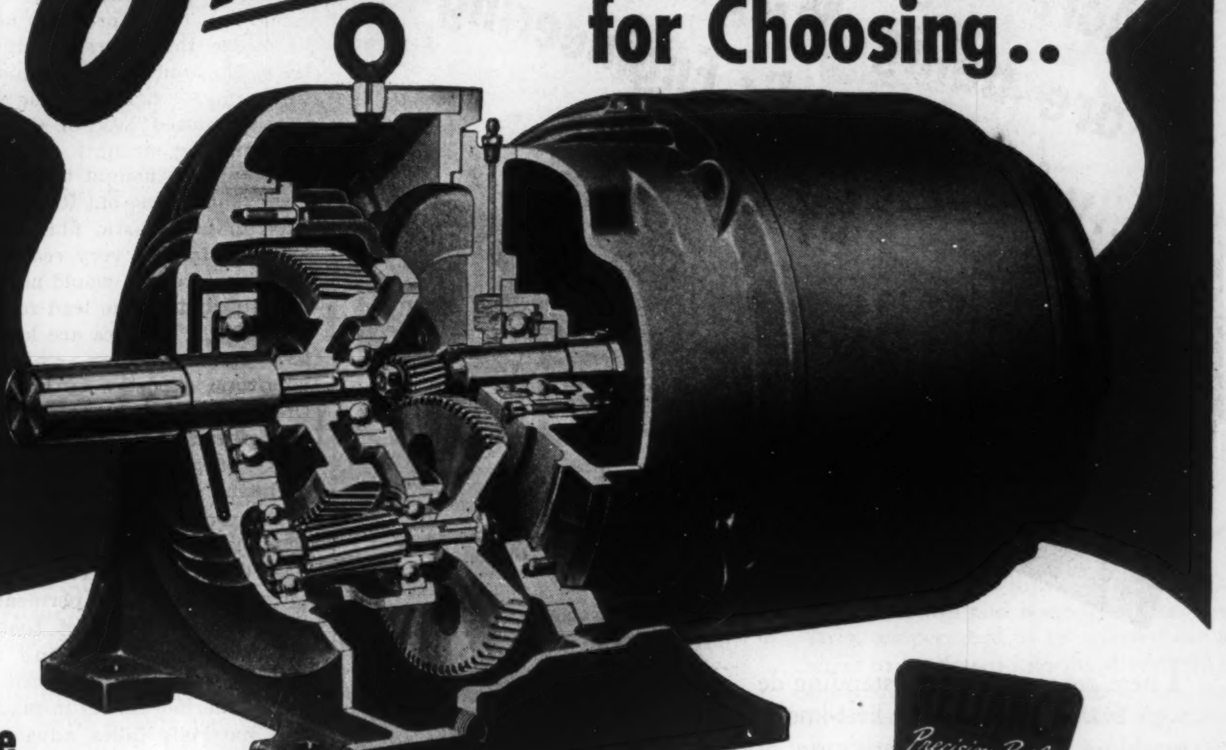
It is said that these single-leaf springs weigh considerably less than the conventional multileaf springs they were intended to replace, but such weight saving can be due solely to the use of higher stresses. The weight of a beam of uniform stress will vary inversely as the square of the stress we allow, and a 20 per cent increase in stress can mean a reduction in weight in the ratio of 100 to 144. However, such an increase in stress can only be justified by better steel, or better surface quality of the steel, coupled with shot peening and prestressing to raise the physical properties.

One spring manufacturer has also been exploring the possibilities of a three-leaf spring, intermediate in width between the conventional and the wide single-leaf type. He proposes tapering the leaf ends either in width or thickness to give equal stressing throughout the beam. Such a design will retain a moderate amount of interleaf friction, which would relieve the shock absorber of a portion of the work of damping the oscillations. *From a paper by N. E. Hendrickson, consulting engineer, presented at the recent SAE National Transportation meeting in Cleveland.*

Plastics in Ordnance Equipment

PLASTICS are used by the Ordnance Department in order to take advantage of some particular group of properties which are unobtainable from alternative materials of construction. Accordingly, the utility of plastics in ordnance items depends

6 INSIDE REASONS for Choosing..



the RELIANCE GEARMOTOR

1 Helical, wear-hardened gears cut from alloy steel forgings and shaved before hardening for correct eccentricity and helical angle and bright, smooth surfaces—factors contributing to quiet operation and longer life.

2 Gear arrangement in simple train minimizes number of moving parts—promotes quietness.

3 Pinion and gear supported and spaced to reduce deflection—permits high load-carrying capacity.

4 Splash system with large oil reservoir assures constant and thorough lubrication of all parts.

5 Anti-friction bearing construction throughout.

6 Reliance *Precision-Built* Motors provide the maximum in dependable and economical power. Types that may be had with GearMotoR are described in GearMotoR Bulletin C-404. Ask also for bulletins describing Reliance *Precision-Built* A-c. Motors—engineered for every power requirement.

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are being MADE BETTER
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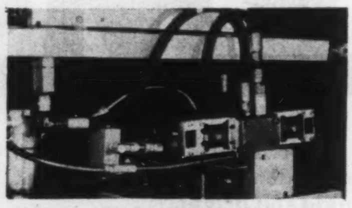
There are many new outstanding design features in today's best-known machines of industry, transportation and agriculture — engineering advancements that add up to provide greater efficiency... new ease of operation ... and lower on-the-job cost.

Design engineers — the men responsible for these product improvements — will also tell you that many of these new advantages and economies stem from the wider use of Electrol's better hydraulic devices.

It will pay you to look for the use of Electrol hydraulic devices in the equipment you buy . . . and it will pay you to feature their use in the products you make and sell.

May we have one of our engineers call at your convenience?

CUSHIONED LANDINGS for the Bell Helicopter are made possible through the use of Electrol Landing Gear Oleos. Like other hydraulic devices bearing the name Electrol, these specially designed units are light in weight, easy to install, service and maintain. And through Electrol's scientific design and production techniques, the economies of manufacture achieved are passed along to the user.



FINGER-TIP CONTROL for broaching machines is provided by this Electrol-developed "hydraulic control package." Heretofore, it often required two men to advance and return a broaching tool to obtain clearance space for the working piece — but today, it requires only finger pressure on a push-button to engage or disengage the tool, or to move the tail stock in either direction from a stationary point.

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FOR BETTER HYDRAULIC DEVICES

Better Designed Products Use Electrol Hydraulics

upon a thorough and detailed knowledge of the properties of each of these materials. In many instances, this involves making advantageous use of a property which is generally considered a disadvantage.

It is generally considered disadvantageous that thermoplastics commonly change so greatly in stiffness with falling temperature, but we have found that it will probably be possible to utilize this characteristic to give us a blow-out plug which will hold increasingly tight as the temperature is reduced. Again, the relatively low bursting strength of plastic film is commonly thought to be somewhat disadvantageous, but it has been possible to use plastic film in place of lead foil for the very reason that its bursting strength would not be greater than that of the lead foil.

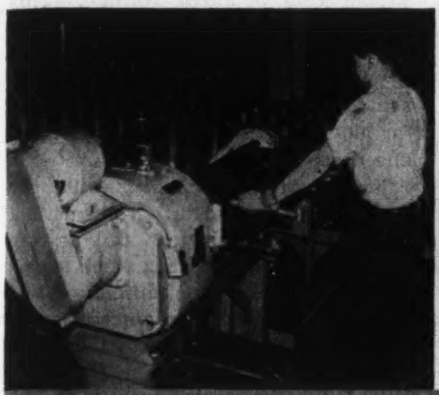
Similarly, plastics are known to be less resistant than metals during long-time exposure to heat, but the Ordnance Department is now recognizing that the low thermal conductivity of plastics makes plastics superior to metals in some applications in the presence of intermittent, short-time blasts of flame. The use of plastics to obtain barriers which are tough but moisture permeable takes advantage of the fact that plastics are not entirely moisture impermeable as so often is wished, and the use of thermoplastics in place of ductile materials takes advantage of a property—cold flow—which is normally considered an unmitigated evil.

Accordingly, it seems safe to say that the most significant applications of plastics in Ordnance materiels are those based upon the most complete knowledge of plastics and which use plastics for what they are.—*From a paper presented by Dr. Lucius Gilman, Ordnance Department, Picatinny Arsenal, at the Remobilization Program sessions of SPI in New York.*

Machine-Tool Transformers

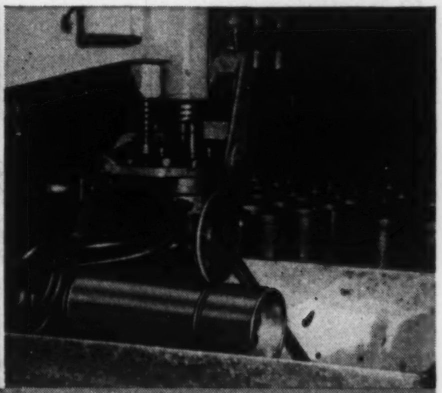
PROPER selection of machine-tool control transformers is necessary for best operation of contactors and relays. Although standardized control transformers are becoming available with regulation characteristics equal to or better than transformers now on the market, consideration must be given to selection of exact transformer ratings for best results.

Control transformers must be able to provide current for both momentary peaks and sustained load without exceeding heating or voltage limitations. The minimum voltage at which contactors or solenoids can be expected to operate is



Rolling silicon bronze to the exact diameter before welding

Resistance welding of longitudinal seam



The bottom is resistance-welded to the shell

REVERE SILICON BRONZE IN RE-DESIGNED EXTINGUISHER

Everyone is familiar with the 2½ gallon fire extinguisher that is operated by turning bottom up. It is to be found in almost every factory, office and school. With it, countless fires have been put out, lives, property, jobs, money saved. Such a standard product tends to be taken for granted; most people naturally assume that it has reached its final perfection. Not so American-LaFrance-Foamite Corp., which some time ago decided to re-design its Alfco extinguishers in the light of the newest technological developments. To the user, the new extinguishers are definitely improved, being free from rivets, 4½ pounds lighter, and much more handsome. To the company, the product has been bettered in other ways, and is more efficiently produced.

Working out this extensive program required careful consideration of the relationships between design and materials, and materials, methods and machines. Alfco wished to abandon rivets and go to seam welding, among other things. Silicon bronze was selected as the material, because that can be easily resistance-welded, possesses strength of mild steel together with the corrosion resistance of copper. Revere and Alfco got together and jointly set up the time, temperature and pressure requirements for clean, sound welds. It was also necessary for Revere to establish the proper tempers for the body sheet so that it will more than withstand the Underwriters' pressure test, but still be formable into a cylinder with beads that locate the top and bottom domes. Similarly, tempers had to be selected for the sheet to be drawn into the domes. In all these and other activities the accumulated knowledge and experience of the Revere Technical Advisors, the welding section of the Research Department and of three Revere mills were used. Finally, the Research Laboratory tested the first production extinguishers to make sure that annealing practices were adequate.

Revere considers this an outstanding example of the benefits possible when a manufacturer and supplier collaborate on mutual problems. You are invited to consider Revere not only as a source of non-ferrous metals, but of know-how in their selection and fabrication.

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BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS.

85 per cent of rated voltage. This 15 per cent reduction in voltage cannot take place entirely within the transformer with safety since some tolerance must be considered for fluctuations in line voltage, for line drop, and for safety factor.

For example, assume that 90 per cent of rated secondary volts at full load is satisfactory as far as the transformer is concerned. This leaves five per cent for fluctuations of line voltage and other variables if voltage is not to drop below 85 per cent.

Maximum instantaneous load and maximum continuous load should be figured in applying the proper size of transformers. Manufacturers can supply values of currents drawn by contactors and solenoids before and after closing. Instantaneous maximum current drawn before closing varies from 3.5 to 15 times the continuous current after the device has closed.

Kva Rating Selected

Having determined the maximum continuous load, a tentative kva rating for the control transformer should be selected. Regulation curves of actual control transformers should then be used in determining the size of transformer best adapted to the job.

Proceeding along a 90 per cent voltage line (as assumed in foregoing) to the curve for the tentative rating of the control transformer, the per cent of rated load that will drop the transformer voltage to this 90 per cent voltage is determined. If this value of per cent of rated load is at least as great as the ratio of maximum instantaneous current drawn by the contactors and solenoids to their maximum continuous current, the size of transformer tentatively selected will be satisfactory. Otherwise a transformer rating will be required that is large enough to insure that the maximum instantaneous current will not drop its secondary voltage below the 90 per cent selected.

Normal loads imposed by the contactors and solenoids have low power factors often on the order of 20 per cent. Regulation at 20 per cent as set forth in NEMA curves is much better than for 100 per cent power factor loads. Use of lights or any heating or other high-power-factor load operated from the machine-tool transformer raises the power factor and increases the regulation.

Because of the good regulation required of the machine-tool transformer, relatively low impedance is offered to an electrical fault so that fault currents are much higher than

NATIONAL OIL SEAL LOGBOOK

ADVANTAGES OF EXTERNAL LEATHER SEALS ON WHEELS AND SIMILAR APPLICATIONS

EXTERNAL WIPE oil seals have important advantages for use on wheels and other mechanisms which are mounted in spindles or protruding stationary shafts. Automobile front wheels, trailer wheels and heavy-duty farm and highway equipment where speeds are low and dirt conditions are severe, are good examples. In such cases, external wipe oil seals are press-fitted onto the shaft and wheels are installed *with* instead of *against* the flare of the sealing member. Thus it is easier to dis-assemble wheels and bearings and it is practically impossible to damage the oil seal when wheels are being replaced.

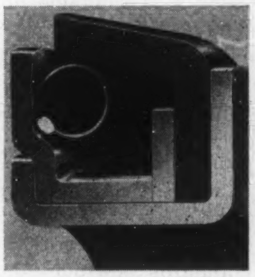
Fig. 1—External Seal with garter spring expander

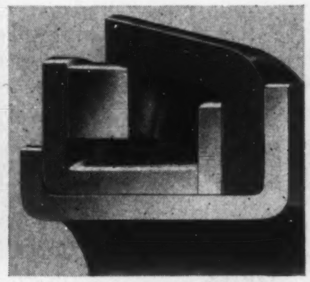
Fig. 2—External Seal with piston-ring expander

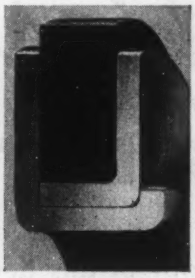
Fig. 3—External felt Seal

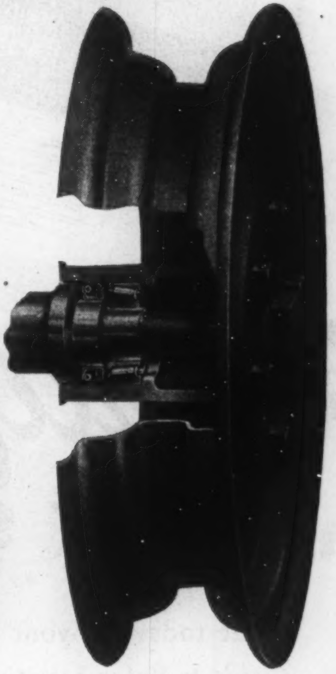
Fig. 4—Typical wheel application

NATIONAL EXTERNAL SEALS FOR SPECIFIC OPERATING CONDITIONS

Operating Speed	Abrasive Conditions	Seal Recommended
High	Moderate dirt	Leather, with garter-spring loading (Fig. 1)
Medium	Very heavy dirt	Leather, with piston-ring expander (Fig. 2)
Very slow	Dust	Felt springless (Fig. 3)

THE wheel application (Fig. 4) is typical of the use of external wipe National seals on farm tractors, binders, harvesters, trailers, etc. Here moderate speeds are found, along with moderate dirt conditions. Fast easy assembly and dis-assembly is a necessity. An exceptionally rugged seal is indicated; and the National leather seal with garter spring expander (Fig. 1) effectively solves the problem.

However, on very heavy equipment operating in extreme dirt conditions where low speeds prevail and torque is no factor, a similar seal with piston-ring expander should be utilized (Fig. 2). Conversely, on such equipment where dirt conditions are very light, a felt seal (Fig. 3) is effective and more economical.

For complete information on the application of external wipe National Oil Seals to your product, call the nearest National Oil Seal Engineer, or write direct.

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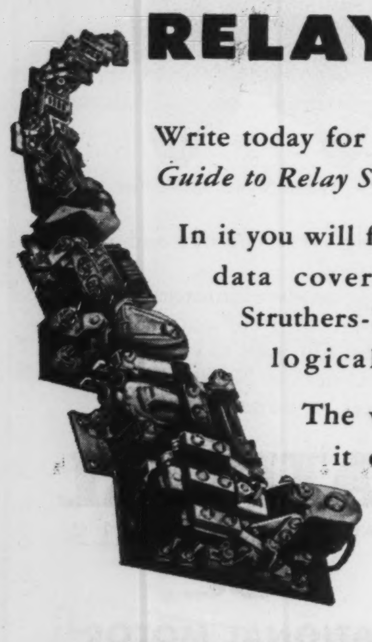

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for transformers with higher impedances. A NEMA recommendation is to furnish a protective device such as a cartridge fuse or a breaker in series with the secondary circuit to protect against these over-currents. The fuse is, of course, simpler and cheaper than the breaker, but if it is to protect the transformer from moderate sustained overloads, the transformer secondary circuit will open too quickly on a heavy inrush of current. If the transformer is fused to permit sudden inrushes, it is not protected from persistent overloads. Combination thermal and magnetic-action breakers are now available for Westinghouse 1 and 1½ kva machine-tool transformers in which moderately prolonged overloads operate the thermally sensitive portion of the breaker while an extremely heavy overload will trip the breaker almost instantly aided by magnetic action.

A number of manufacturers are now offering a special line of transformers having suitable regulation characteristics, and giving regulation curves at both high and low power factors. The proposed standards list transformers in three frequency categories: 60, 50, and 25 cycles. There are seven kva ratings for 60-cycle, 5 for 50-cycle, and 3 for 25-cycle frequencies. The proposed standards include dielectric tests, heating tests, and regulation characteristics. *From a paper by C. E. Herr, specialty transformer engineer, Westinghouse Electric Corp., presented at the Machine Tool Forum in Buffalo, N. Y.*

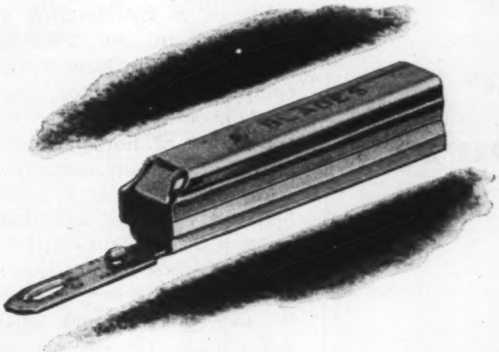
Dual-Fuel Diesels

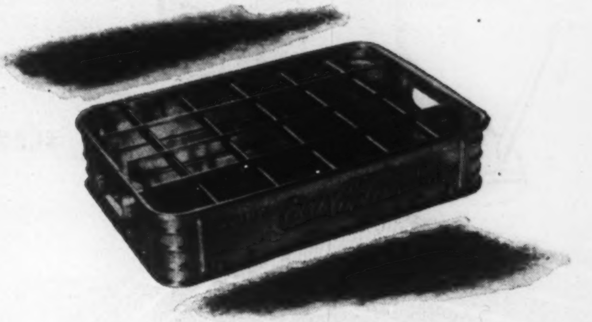
LATEST and probably most spectacular development in the diesel-engine field has been the introduction of an engine operating on the full diesel cycle capable of handling gaseous fuels.

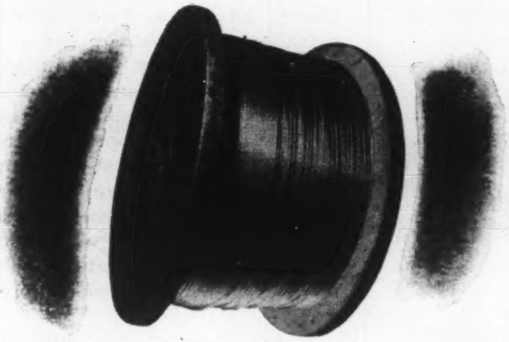
The first American engine to successfully handle low-pressure gas as a fuel for operation on the full diesel cycle was demonstrated at the Buffalo Works of Worthington Pump and Machinery Corp. in August, 1944. This engine utilizes a small amount of fuel oil injected in the conventional manner as a pilot ignition system to insure ignition of the gas and to properly control the ignition point in each cylinder. The engine is so arranged that the pilot-oil fuel can be in quantities as low as 5 per cent of the total heat requirement of the engine and can be increased to any amount up to 100 per cent of the engine heat requirements.

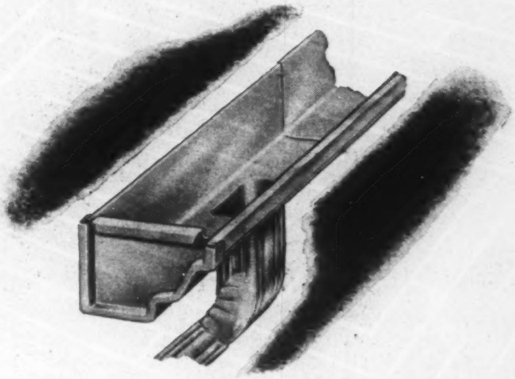
Early in 1945 a supercharged dual-fuel engine was also demonstrated

BEAT COMPETITION WITH IMAGINATION
. . . REDESIGN WITH ALUMINUM









● You're looking at ideas. Each of these redesigned products is a story of lower costs and increased appeal to consumers. That automatic blade changer, for instance, in naturally attractive aluminum eliminates a corrosion-resistant coating operation. The change from brass also provides a substantial material economy.

The beverage case is lighter, stronger, more attractive, now that aluminum serves instead of wood. It is made without bolts, rivets or welds. The cost per trip is lower. And it is easier to keep clean.

Aluminum cable, steel reinforced, is ending a shortage and bringing electric power to thousands of families for the first time. Aluminum costs less than copper and the lighter weight permits longer spans for reduced stringing costs.

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Many of the products you see daily can be improved through the use of aluminum. This modern metal lends itself to modern design. Aluminum is ⅓ the weight of ordinary metals, yet it is strong. Every pound purchased offers three times the material for production. It handles faster, gives products a smart appearance. It takes a wider range of finishes than most other metals. But red-rust is never a problem, so finishing cost is frequently eliminated.

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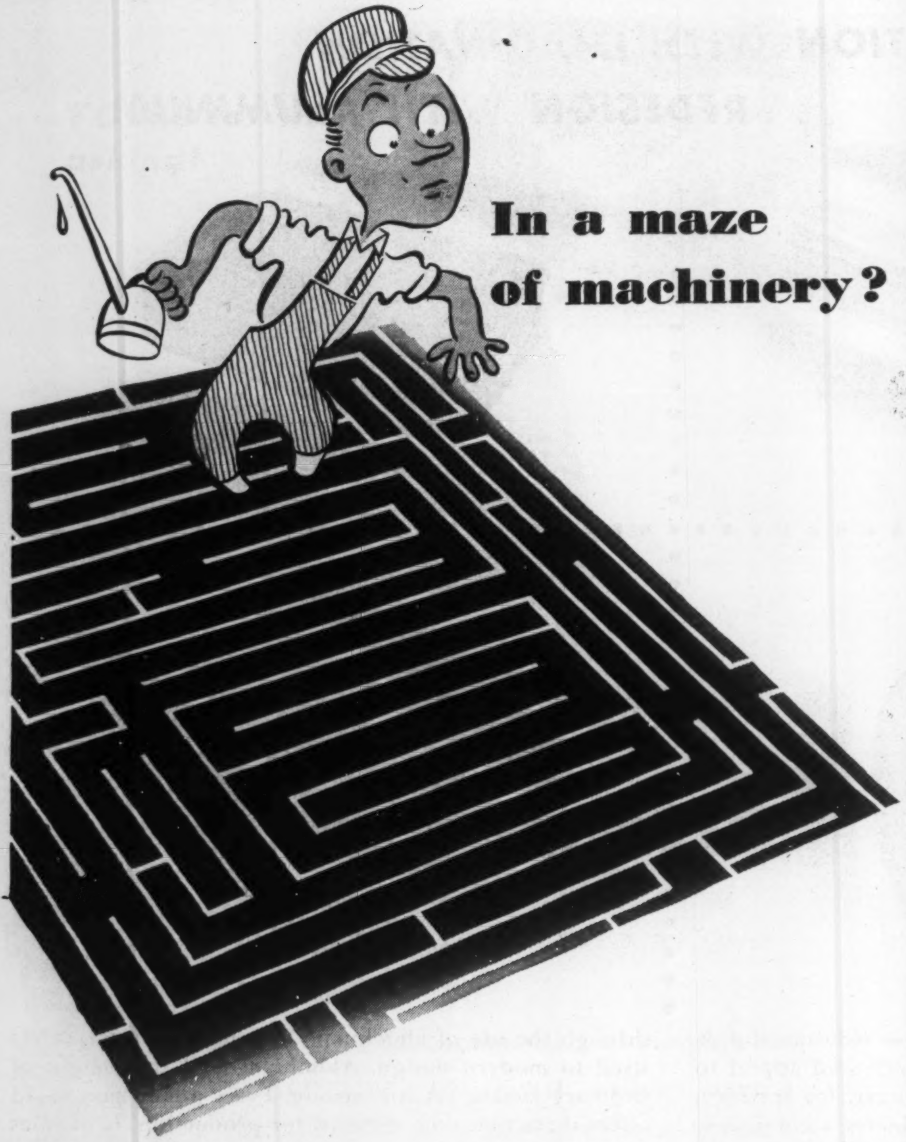

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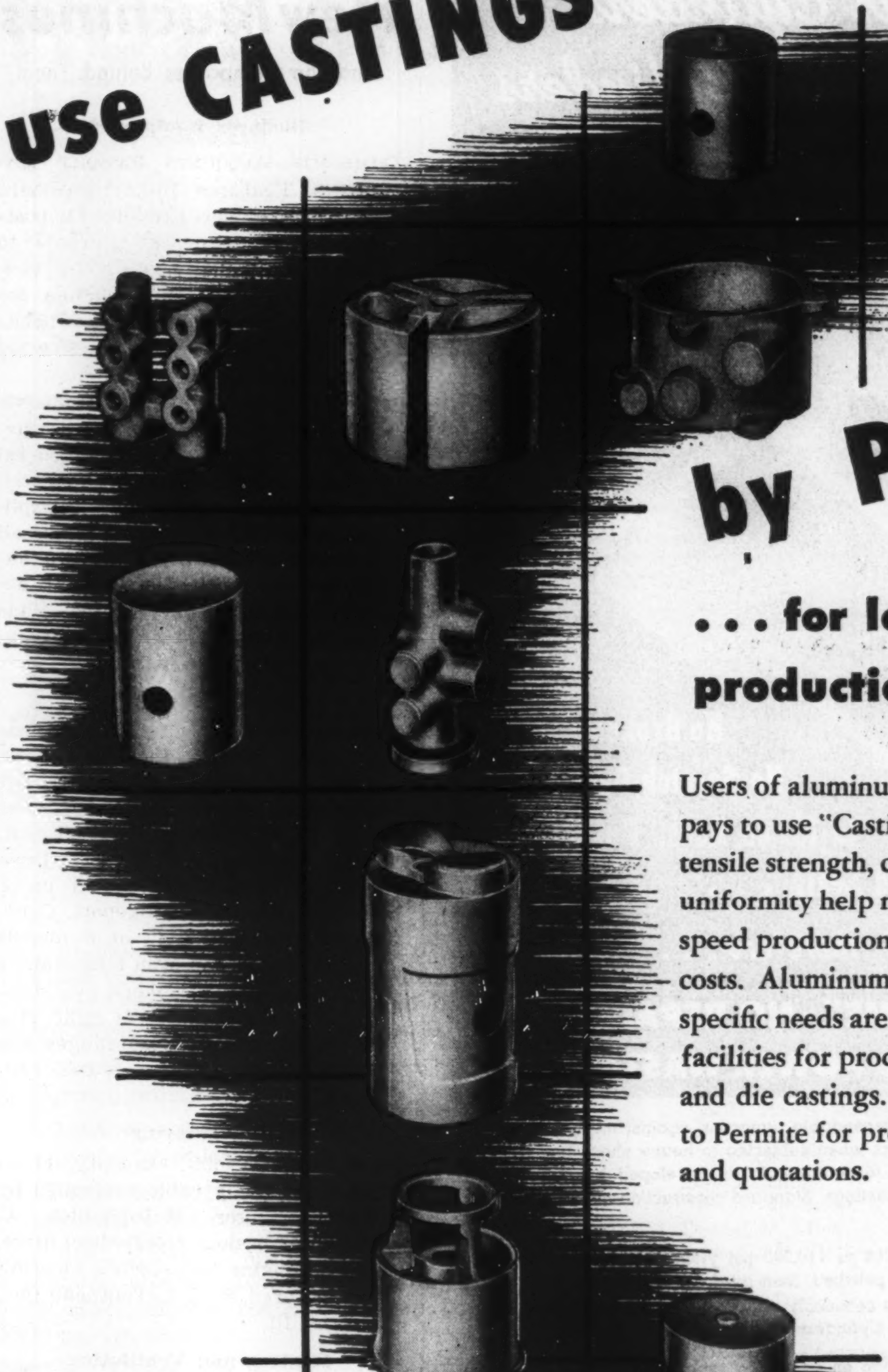
by Worthington and announced to the trade for general application. This was the world's first supercharged dual-fuel engine. The first commercial application of the dual-fuel principle in this country was made on a Worthington gas engine operating in the Tallman's Island sewage plant in New York City with completely satisfactory results. Since announcement of these units many thousands of horsepower have been sold and are successfully operating.

In developing this system it was believed its chief application would be in sewage plants utilizing sewage gas fuel. For many years it has been the practice in larger sewage plants to use conventional spark-ignition gas engines for driving blowers and pumping equipment, or in some cases for driving generators to provide station power. These engines used sewage gas as a fuel, but in practically all cases were handicapped because gas was not generated in sufficient quantity to maintain constant full-load operation. In these cases it was invariably necessary for the sewage plant operators to contract with their local gas company for additional manufactured or natural gas to supplement their fuel supply or to contract with their local electric utility for standby power, many times at unreasonably high rates.

Introduction of the dual-fuel engine has made it possible to supplement the sewage gas fuel supply with the necessary amount of oil to maintain constant full-load operation without the necessity of contracting for an outside supply of gas or for maintaining standby electrical power. A further advantage realized by sewage plant operators is the ability of the engine to operate on 100 per cent oil during the time the plant is being put into operation and before a supply of gas has been generated. The ability of the Worthington dual-fuel engine to operate on any proportion of oil and gas from 5 per cent oil and 95 per cent gas to 100 per cent oil enables the operators to use all the gas generated at all times. Governing of the engine is so arranged that the governor will call for the maximum amount of gas and will continue to use this maximum amount so long as it is available. However, as the quantity of gas diminishes the governor will automatically provide additional oil fuel, thus eliminating any necessity for manual adjustment of the relative quantity of the two fuels being used. *From a paper by R. N. Tate, application engineer, Worthington Pump and Machinery Corp., presented before the National Association of Power Engineers in Indianapolis.*

use CASTINGS



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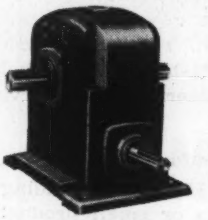
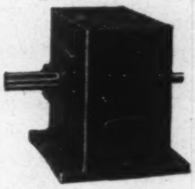


Single reducers. 5 sizes, No. HS-0-1-2-3-4. Ratios, 5-1 to 100-1. Capacities, ¼ HP to 5 HP. Higher HP is attained in the heavier cases (with low ratios). The input shaft or worm is below, the output shaft above. Output shaft may extend to right, to left, or both right and left.

OHIO HELICAL SPEED REDUCER, SINGLE REDUCTION

The HH line of Helical Reducers is available in 3 sizes; Nos. HH-1-2-3. Ratios are from 3-1 to 12-1. Torque capacities 147 in. lbs. to 1450 in. lbs. The double reduction unit No. DHH2 has ratios ranging from 9 to 1 to 30 to 1, with capacity of 1500 inch lbs.

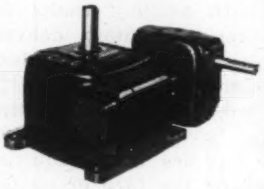
OHIO DOUBLE SPEED REDUCER D-SERIES



For heavy duty service, Nos. DOT and D-1-3-4-5-6. Radial thrust bearings on high speed shaft, tapered roller bearings on all others, except No. DOT, with tapered roller bearings. Ratios to 3200 to 1. Torque capacities, 25 to 12000 in. lbs.

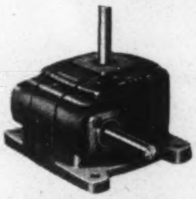
OHIO GEAR speed reducers

OHIO DOUBLE SPEED REDUCER DPL



Double reduction in DPL series is obtained by adding an attachment case to PL single reducer. Three sizes, Nos. DPL-1-2-3. Ratios, 100-1 to 24000-1. Torque capacity, 900 in lbs. to 5800 in lbs.

OHIO SPEED REDUCER PL SERIES VERTICAL OUTPUT



Four sizes, PL-0-1-2-3. Ratios, 5-1 to 100-1 Capacities ¼ HP to 4 HP. Output shaft is vertical and extends from top of case, from bottom of case, or both top and bottom. Higher HP is attained in the heavier cases (with low ratios).

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Worm gear of special gear bronze. Worm and motor shaft of hardened steel, integral and ball bearing mounted. Output shaft extra heavy, mounted on roller bearings. Motor precision built of drip-proof construction. Heavy duty ball bearings throughout. Available in ¼ and 1/3 HP, 115 and 230 volt, single phase and 220/440 volt 3 phase.

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2. Readily available, they eliminate waiting time for special orders.
3. Parts and replacements are quicker, saving expensive down-time.

Ohio Stock Reducers are available in ratios from 3:1 to 24000:1; single reduction capacities from ¼ H.P. to 15 H.P.; double reductions from 25 in. lbs. to 12000 in. lbs. torque.

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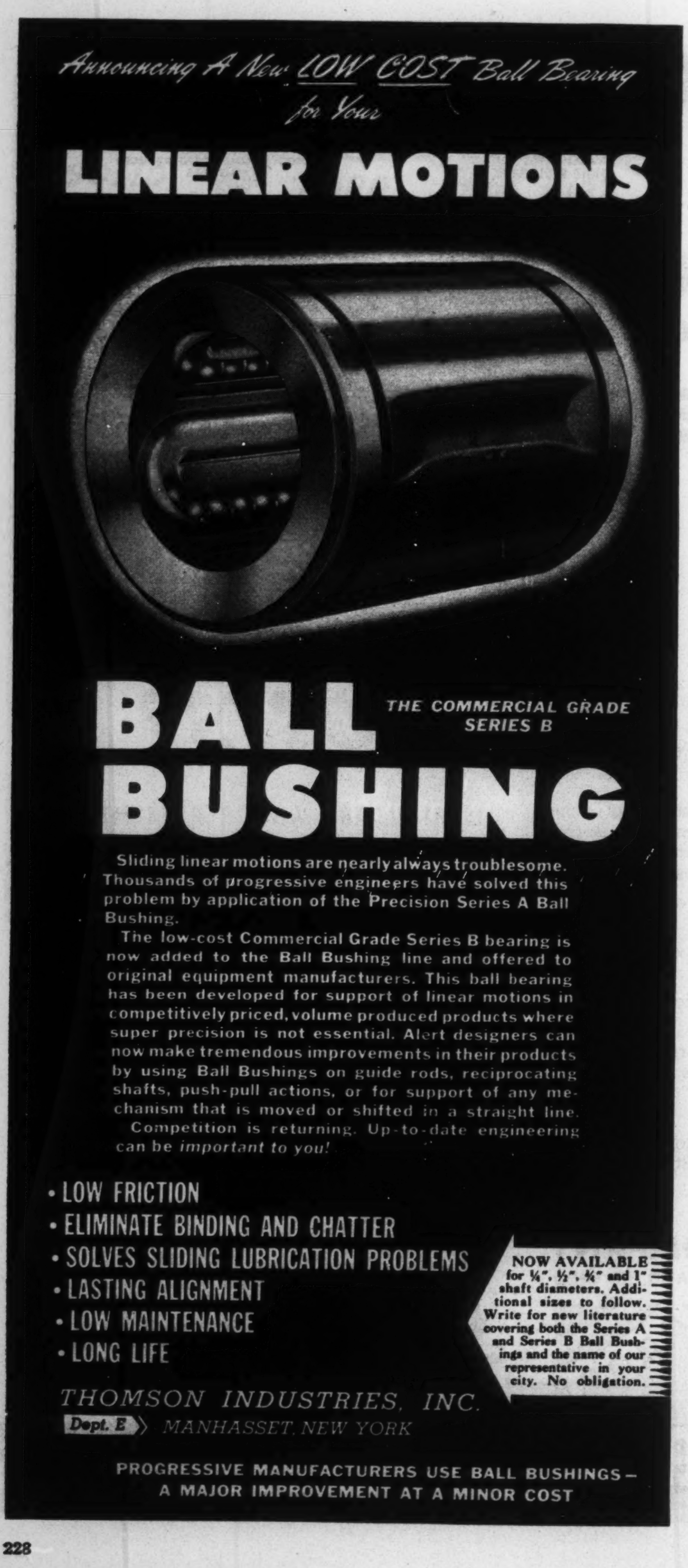

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10½-in. deep and includes rubber-mounted 4-bladed fan. Palmer Mfg. Corp., Phoenix, Ariz.

CABINET TYPE WINDOW FAN. Reversible, variable-speed units available in 2 sizes: 24-in. fan delivering 4500 cfm has speed variation of 660 to 460 rpm; 30-in. fan delivering 6500 cfm has speed variation of 400 to 270 rpm. Both models powered by ¼-hp motors. Chelsea Fan and Blower Co. Inc., Irvington, N. J.

Manufacturing

BELT GRINDER. For hand grinding of standard tools or small production parts. Drives 2 belts at 1600 or 3200 fpm. Cloth-backed silicon-carbide belts have grits from 80 to 600 for wet grinding with water or water soluble oils. Valve-controlled spray head supplies coolant to each belt. Recirculating cooling system provided with settling tanks for removing residue. Pump delivers clean coolant to either or both belts. Buehler Ltd., Chicago, Ill.

SPECIAL PURPOSE MILLER. Primarily for cutting bevel gears and pinions. Also handles work requiring slots milled on the face or outside diameter and hex, square or similar milling. Vertical spindle motor-driven through V-belts and adjustable vertically and horizontally. Table is air and cam actuated for rapid advance to cutting position and proper feed for cutting. Work spindle attached to table swivels through 90 degrees. Capacity, up to 8-in. diameter; cutter speed, up to 125 sfpm; and cutter feed, to 0.003-in. per tooth. Whiton Machine Co., New London, Conn.

SPECIAL BORING MACHINE. Automatically bores and faces side gear pockets of differential cases. Produces 100 pieces per hour at 100 per cent efficiency. Operator loads and unloads, balance of cycle is automatic. Cross Co., Detroit, Mich.

LATHE. Capacity; 11-in. swing, 1-in. collet capacity for draw-in collets and center distances of 24 and 36 in. Spindle speeds, 45 to 1500 rpm. Spindle runout, within 0.0005-in. measured 12 in. from bearing. Quick-change gears provide selection of 48 threads and feeds. Available in cabinet and floor models. Logan Engineering Co., Chicago, Ill.

INERT GAS ARC WELDERS. Uses single-tube, full-wave, self-rectifying type oscillator. Unit remains on frequency regardless of working conditions, changes in humidity or temperature. Welding current comes on only after high frequency arc is drawn. Electrodes do not stick because no current flows while electrode is in contact with work. Available in NEMA ratings of 150,

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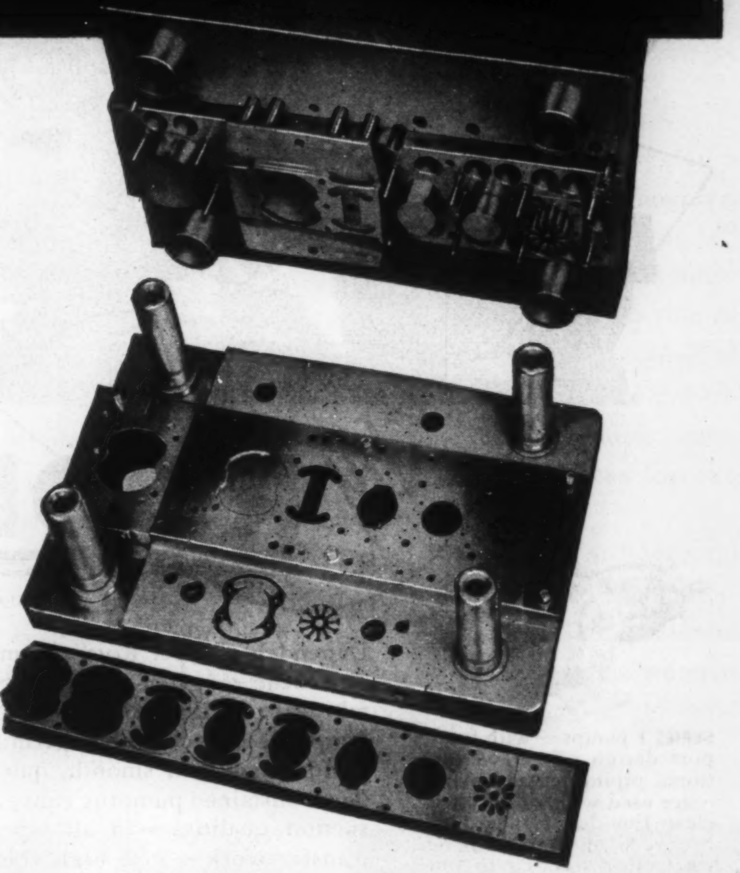


BLANKING DIES, like those illustrated, are expensive precision tools—literally, in many cases, "worth their weight in gold." The Cleveland Form Tool Company, Cleveland, Ohio, specify Meehanite castings for such units. The die shown takes a 42-ton blow at 160 strokes per minute and can produce 5 million blanks before replacement.

Meehanite castings are manufactured under processes which permit accurate structural control of the metal, and thus the dependable achievement of the required properties for the job. They provide:

1. High Compressive Strength.
2. Adequate Shock and Vibration Absorption.
3. Dimensional accuracy under impact.
4. Freedom from "after-machining" distortion.
5. Density—Uniformity—Machinability.

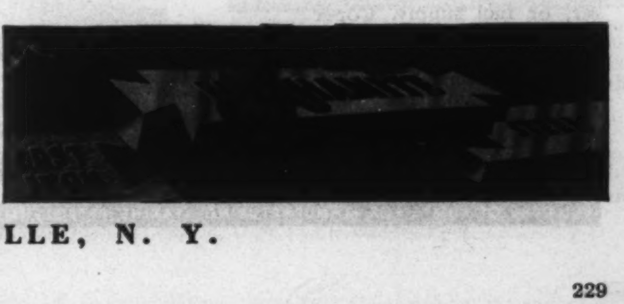
Build "QUALITY" into your product with Meehanite Castings.

We have a Bulletin 28 entitled "7 Questions and Answers About Meehanite Castings" and if you would like a copy write to any of the foundries listed.

MEEHANITE FOUNDRIES

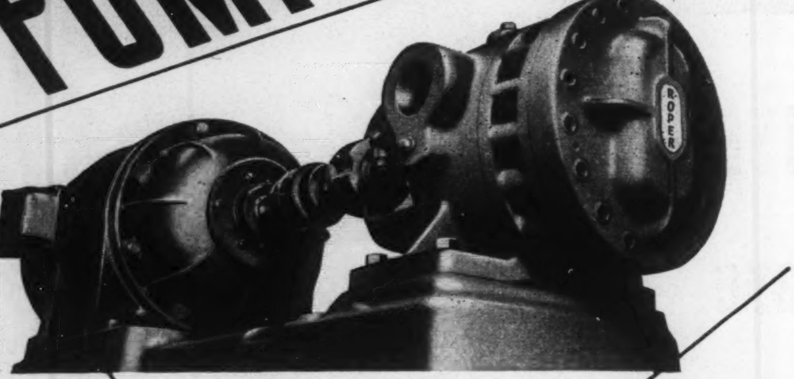
American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. Long Ltd.	Orillia, Ontario
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
The Henry Perkins Co.	Bridgewater, Massachusetts
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

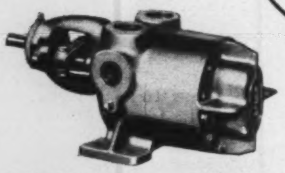


Meehanite NEW ROCHELLE, N. Y.

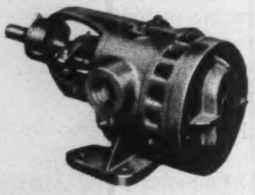
PUMPS FOR ALL INDUSTRIES



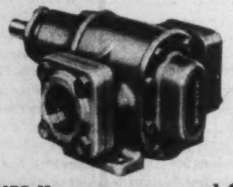
by ROPER



SERIES F pumps — with four-port design offering 8 optional piping arrangements —are used with all kinds of clean liquids. Standard or bronze fitted; packed box or mechanical seal. Up to 300 p.s.i.; 1 to 300 g.p.m.



SERIES H pumps are used for hydraulic mechanisms; other places where high pressures are required. Packed box or mechanical seal. Pressures up to 1000 p.s.i.



SERIES K pumps are used for hydraulic service, fuel transfer, or fuel supply. Roper Venturi suction and discharge principle. Packed box or mechanical seal. 150 p.s.i.; ¾ to 50 g.p.m.

Dependable Roper Rotary Pumps are built in a wide range of sizes and capacities to take care of diversified needs in industry. Simple, compact design permits optimum performance and smooth, quiet operation under sustained pumping runs . . . maximum suction qualities — in all types of liquid transfer work — give high volumetric efficiency with low power requirements.

Whether you work with thin or thick liquids, there is a Roper available to handle virtually any clean liquid. Pumps are standard fitted and bronze fitted — have capacities from ¾ to 300 g.p.m. — pressures up to 1000 p.s.i. — speeds up to 1800 r.p.m. — mountings and drives for every practical need.

Investigate Roper Pumps and their adaptability to your installation. This is the *quick, sure* way to solve your pumping problem.

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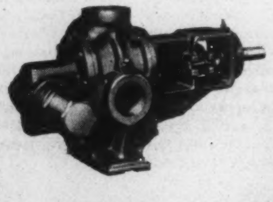

SERIES 3600 pumps ase used for general purpose work handling thin or thick liquids. Standard or bronze fitted; with or without built-in relief valve. 40 to 200 g.p.m.

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BUILDERS OF PUMPS FOR MANUFACTURING, MARINE, PETROLEUM, AND PROCESS INDUSTRIES

200, 300, 400, 500, and 750 amp. Glenn-Roberts Co. Inc., Indianapolis, Ind.

DIECASTING MACHINE. Vertical type cold chamber machine especially for production of parts having inserts. Capacity; 4½-lb aluminum castings, die space of 17¾ in. between bars. Hydraulic operation with electric controls. Kux Machine Co., Chiacgo, Ill.

CENTER DRIVE LATHE. Turns and chamfers all bearings and oil-pump gear flanges and cuts interrupted oil grooves on camshafts in one operation. Special 2-jaw scroll chuck clamps and drives camshaft from cam located next to No. 3 bearing. Grooving attachment driven from main driveshaft. Machine is automatic except for loading; produces 80 camshafts per hour at 80 per cent efficiency. Seneca Falls Machine Co., Seneca Falls, N. Y.

UNIVERSAL CUTTER AND TOOL GRINDER. For small shops with limited requirements or larger plants requiring more than one machine. Handwheel raises and lowers column and head; lever or handwheel actuates longitudinal movement. Head swivels through 180 degrees, table swivels to 90 degrees either side of center. Table size, 5 by 30 in.; longitudinal table movement, 16 in.; cross movement of wheel, 8 in.; vertical movement of spindle, 8 in. Gallmeyer & Livingston Co., Grand Rapids, Mich.

BENCH PRESS. Foot-operated unit fitted with cutting head. For cutting wire, rod or sheet metal. Standard head can be replaced with heads for indenting, knock-outs, nibbling, "U"ing and notching. Aircraft-Marine Products Inc., Harrisburg, Pa.

CLOSURE PRESSES. For producing closures or threaded parts. In 50 and 150-ton units, presses require only 15 seconds plus curing time to automatically load, close, open, unscrew, and eject closures. Larger model will produce 5400 24-mm molded closures per hour. Die area of 150-ton model; 12 by 18½ in., or 19½ by 24 in. F. J. Stokes Machine Co., Philadelphia, Pa.

MOLDING PRESS. For high production molding of plastic tube bases, fluorescent sockets, receptacles, flanged bottle tops, knobs, etc. Capacity, 150 tons. Uses either preform or powder feed. Positive ejection accomplished through separate ejection cylinder. F. J. Stokes Machine Co., Philadelphia, Pa.

COMBINATION WELDER. For spot welding, arc welding, soldering and brazing. Suited for maintenance

Boosts Welding Speeds 75% with "Manual Lincolnweld"

By EDW. F. ARNTZEN
Sales Engineer
A. C. Woods & Co., Rockford, Ill.

USE of the hidden arc welding process of the "Manual Lincolnweld" in the fabrication of machine tool weldments has increased our welding speeds three to six times over previous hand welding . . . has eliminated spatter cleaning, minimized joint preparation, and reduced distortion and cracking problems. These cost savings and product improvements contribute materially to the advantages already gained by the changeover of these parts to welded design.

In fabricating the weldment shown in Fig.1, we assemble and hold in place the various members by tack welding. The units are then sent to the welding floor for complete welding. Finish welds are made with the "Manual Lincolnweld" machine except at inaccessible places where hand welding is used. On parts such as this, we have increased welding speed 50% to 75% with "Manual Lincolnweld." All welds were made with a single pass, and very little distortion and no cracks were encountered.

To weld channels into box sections for press frames, we clamp the welding gun to a radiograph as shown in Fig. 2. Joints are ⅜" thick, bevelled. The 45-inch single butt welds (one on each side of the box) are made at a speed of 25 inches per minute. Floor-to-floor time is 10 minutes, compared to 30 minutes for the former method.

The high speed of "Manual Lincolnwelding" reduces distortion and joint-cracking problems which were formerly encountered in large parts such as the base shown in Fig. 3.

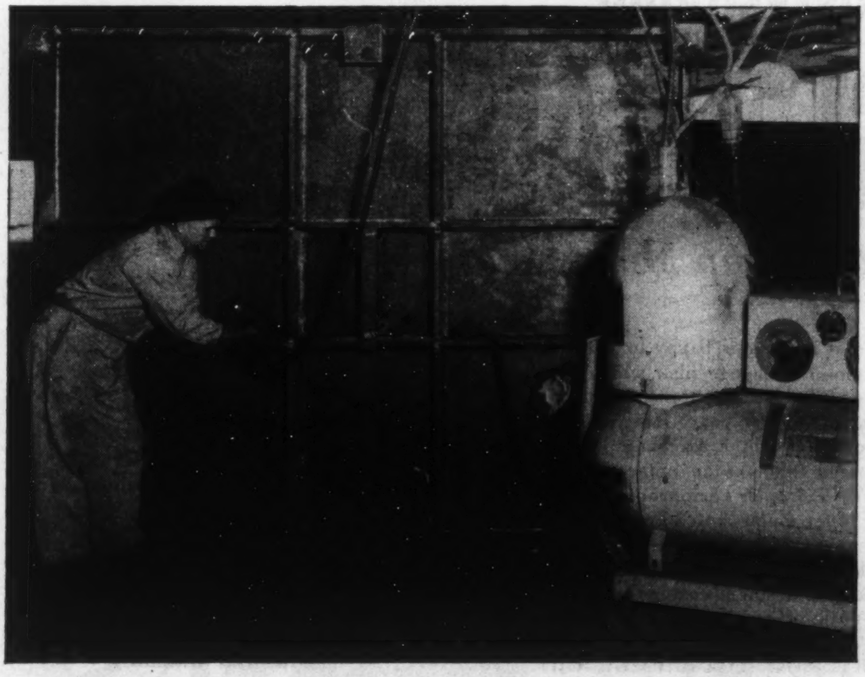


Fig. 1. "Manual Lincolnweld" fabricates this weldment at a speed of 50% to 75% higher than that of former method and eliminates cleaning.

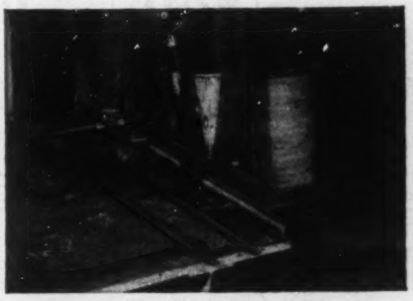
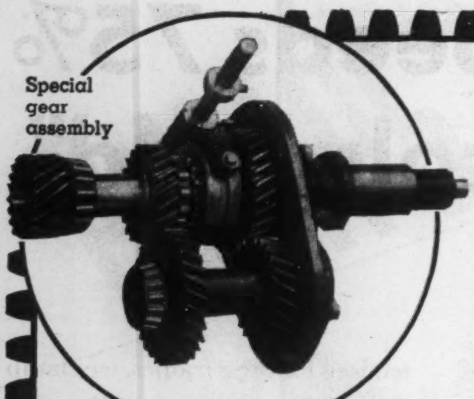


Fig. 2. Mounted on radiograph carriage, "Manual Lincolnweld" gun boosts output of these box sections 200%.

Fig. 3. Speedy, concentrated heat of "Manual Lincolnweld" reduces distortion and cracking problems in welding of parts such as this base.

The above is published by **THE LINCOLN ELECTRIC COMPANY** *in the interests of progress.*

Write for free copy of "Manual Lincolnweld," Bul. 373. The Lincoln Electric Company, Dept. 16, Cleveland 1, Ohio.



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GENERAL ELECTRIC

and repair departments or for other light metal fabrication jobs. Throat depth of 10 in. permits spot welding to center of 20-in. sheet. Width, 14 in.; height, 19¾ in.; length, 26⅝ in. Delta Manufacturing Division of Rockwell Mfg. Co., Milwaukee, Wis.

PLASTICS MOLDING MACHINE. Straight-ram type, hydraulic, semiautomatic press has 200-ton capacity. For molding large parts having deep draws and heavy sections, such as radio cabinets, telephone bases, etc., and for general-purpose molding. Includes automatic cycle control, low-pressure hydraulic system and 3-speed controlled closing. F. J. Stokes Machine Co., Philadelphia, Pa.

STRAIGHTENING PRESS. For straightening iron castings prior to machining. Equipped with special dies in which castings are placed on removal from normalizing furnace. Production capacity, 400 pieces per day. Includes safety-release valve, variable-speed ram, movable workhead, adjustable table, screw type ram, and auxiliary return springs on upper half or die. Dake Engine Co., Grand Haven, Mich.

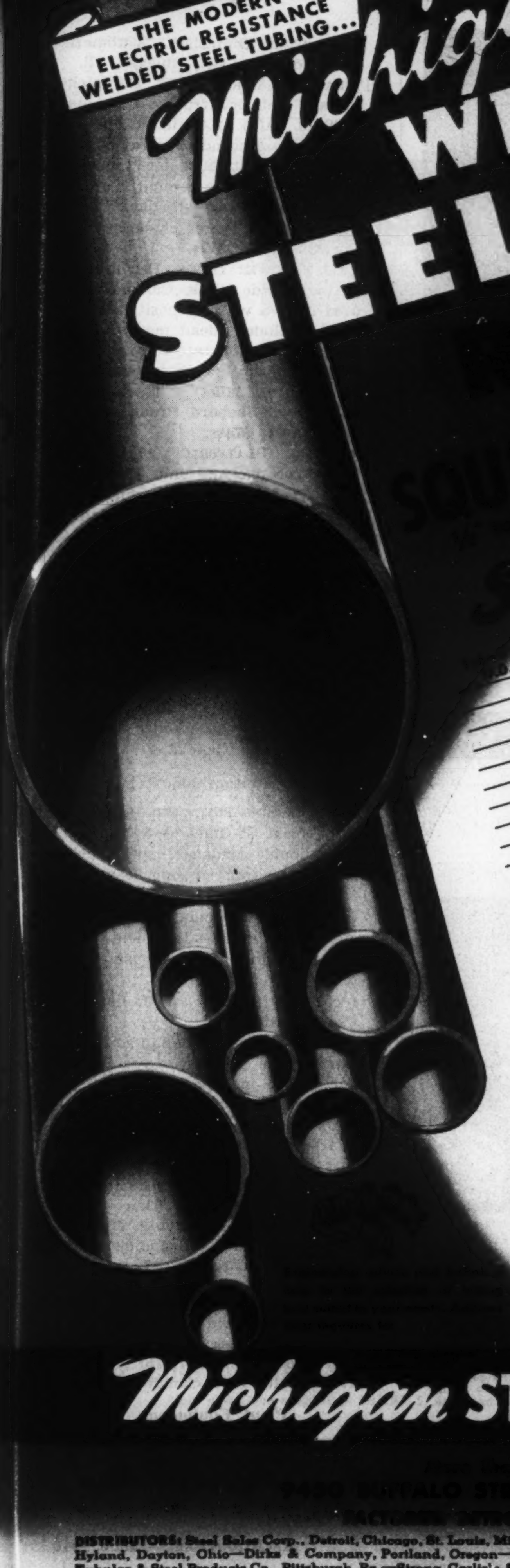
MULTI-BARREL TUMBLER. Deburring and polishing machine for mass finishing of metal and plastic products. Will handle 15 different items simultaneously. Variable features include wet or dry tumbling, range of speeds, and rotary, centrifugal or end-to-end action. Circular mounting plate has 6 distances from center for attachment of various shaped barrels. Hungerford Corp., Big Flats, N. Y.

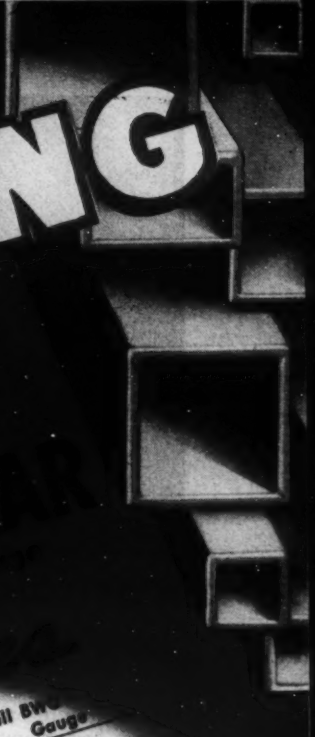
ADJUSTABLE TAPPING HEAD. Without overhang. Geared drive, with needle bearings on all spindles and ball thrust bearings throughout. All parts enclosed for pressure lubrication. Supplied with 3 spindles for equal adjustment in line; and with 3, 4, 5 or 6 spindles for equal adjustment on bolt circles. Errington Mechanical Laboratory Inc., Staten Island, N. Y.

EXTRUSION PRESS. Hydraulic, self-contained machine for economical production of rods and shapes from light metals and other nonferrous alloys. Capacity, 500 to 1000 tons. Production rate, 50 to 60 billets per hour. Hydropress Inc., New York, N. Y.

Material Handling

ROLL HANDLER. For use with electric fork trucks. Handles paper rolls from 24 to 48-in. diameter and up to 60 in. long. Motorized unit revolves clamps through 360 degrees. Clamping arms operated by independent hydraulic rams and are





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1/2" to 2" 22 Gauge 1" to 2 1/2" 14, 16, 18 Gauge

Standard Sizes

Diameter O.D. Size	Maximum Wall BWG Decimal	Maximum Wall BWG Gauge	Minimum Wall BWG Decimal	Minimum Wall BWG Gauge
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3/8	.065	16	.022	24
1/2	.083	14	.022	24
5/8	.095	13	.022	24
3/4	.095	13	.022	24
7/8	.095	13	.022	24
1	.095	13	.028	22
1 1/8	.095	13	.028	22
1 1/4	.095	13	.028	22
1 3/8	.095	13	.028	22
1 1/2	.095	13	.035	20
1 5/8	.120	11	.035	20
1 3/4	.120	11	.035	20
1 7/8	.120	11	.035	20
2	.148	9	.035	20
2 1/8	.148	9	.035	20
2 1/4	.148	9	.035	20
2 3/8	.120	11	.035	20
2 1/2	.148	9	.035	20
2 5/8	.120	11	.035	20
2 3/4	.148	9	.035	20
2 7/8	.148	9	.049	18
3	.148	9	.049	18
3 1/8	.148	9	.049	18
3 1/4	.148	9	.049	18
3 3/8	.148	9	.049	18
3 1/2	.148	9	.049	18
3 5/8	.148	9	.065	16
3 3/4	.148	9	.065	16
3 7/8	.148	9	.065	16
4	.148	9	.065	16

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JACKLIFT POWER TRUCK. Permits operator to ride truck. Can be operated from a walking position if desired. Includes "dead man" brakes and ability to operate controls with handle in any position. Available in platform, pallet or tractor models. Lewis-Shepard Products Inc., Watertown, Mass.

ELEVATING PLATFORM. Flush-with-floor type package unit. Furnished with 30 by 30-in. top which elevates to 24 in. Hydraulic foot pump handles 2000-lb loads. Optional features include larger platforms, lifts to 36 in. and power operated pump. Lyon-Raymond Corp., Greene, N. Y.

PNEUMATIC HOIST. Portable. Capacity, 2000 lb. For machine shop or other repair work. Variable-speed piston locked in position by automatic check valve when air hose is detached. M. T. Weller & Son Mfg. Co., Lake Geneva, Wis.

Photographic

CONDENSER ENLARGER. Handles negatives from 35 mm to 5 by 7 in. Uses double-condenser optical system, consisting of one 9-in. and one 10-in. plano-convex condenser. Counterbalanced enlarging head designed for rapid adjustment. Unit has rack and pinion focusing and will take lenses from 3 to 7½-in. focal length. Burke and James Inc., Chicago, Ill.

SOUND MOTION PICTURE PROJECTOR. Single case unit for 16-mm film. Includes 8-in. speaker in lid of case, which can be placed next to projector or screen. Uses nylon gears for quiet and long-life operation. Includes cooling at either sound or silent speeds, special framing which adjusts position of film in gate without moving aperture plate, automatic rewinding without changing reels, and even-tension take-up regardless of amount of film on reel. Projector delivers 10-watt output from 4-stage amplifier with less than 5 per cent distortion. Radio Corp. of America, RCA Victor Div., Camden, N. J.

Plant Equipment

WATER COOLER. Foot-pedal models in 2 sizes, 9 and 15 gallons per hour under average conditions of 80 F room temperature with 70 F in-

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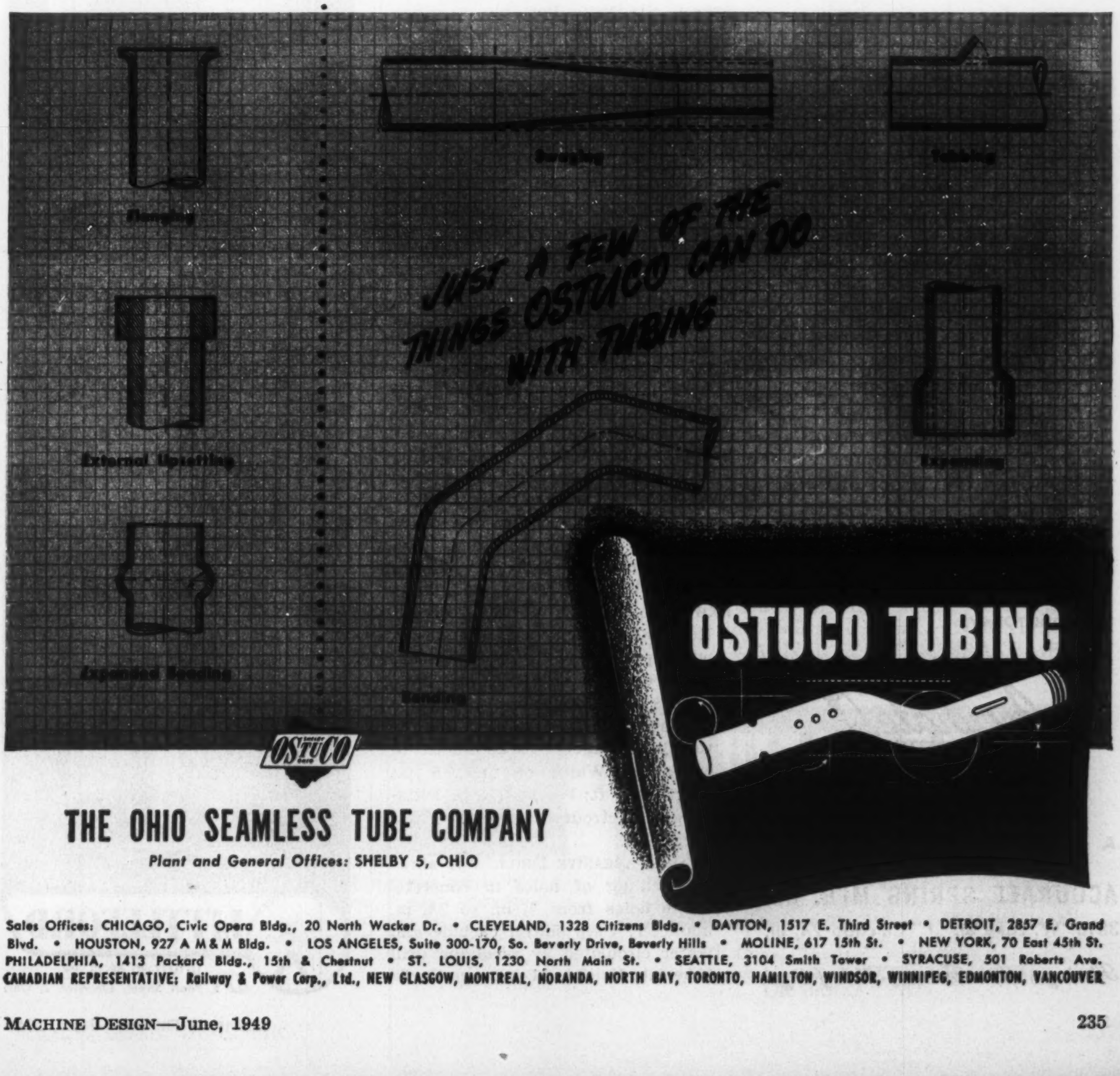
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let water cooled to 50 F. Dimensions, 14 by 15 by 40⅜ in. Stainless steel top and water tank, welded construction. Cordley & Hayes, New York, N. Y.

NAMEPLATE MARKING MACHINE. Bench style pneumatic marking machine for production marking of nameplates where there are frequent changes in character alignment and nameplate size. Maximum size nameplate, 5½ in. long by 4 in. wide when marking area is in center of plate. Stock character sizes; $\frac{1}{16}$, $\frac{3}{32}$ and ⅛ in. Jas. H. Matthews & Co., Pittsburgh, Pa.

DEGREASING MACHINE. Electrically-heated, thermostat-controlled, twin-tank machine for automatic vapor degreasing of parts. Dimensions of stainless steel vapor tank, 18 by 18 by 32½ in. Solvent vaporized by 220-volt heating elements. Adjacent dipping and flushing tank of same size used when vapor cleaning not required. Circo Products Co., Cleveland, O.

STEAM CLEANER. Portable machine weighs 500 lb. For cleaning of machine tools, windows, walls, fixtures, etc. High pressure steam mixed with detergent in correct proportion at jet. Electrically heated boiler has 30 kw capacity, operates on 220-volt, single or polyphase a-c. Unit mounted on steel dolly with ball bearing rubber-tired casters. Livingstone Engineering Co., Worcester, Mass.

VIBRATING SCREENS. For rough sizing. Made with stepped, punched plates having tapered, elongated openings. Either single or multiple-deck screen plates. Screen is actuated by rheostat-controlled vibratory feeder. Syntron Co., Homer City, Pa.

STRADDLE TRUCK. Capacity; 18,000 lb. Powered by 6-cylinder engine; has 4 speeds forward and reverse. Without load, truck will turn in average radius of 12¼ ft. Includes pneumatic tires and 4-wheel hydraulic brakes. Hyster Co., Portland, Oreg.

DEHUMIDIFIER. For warehouses, etc. Removal capacity of 700 lb of water per day from air registering 90 F drybulb or 75 F wet bulb. Unit is dual-adsorbent type machine employing activated alumina as the drying agent; is automatic in operation. Width of unit, 5 ft; length, 8½ ft; height, 7½ ft. Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.

PORTABLE ABRASIVE DRILL. For abrasive-drilling of holes in concrete. Drills holes from ¾-in. to 2¾-in. diameter. Uses silicon carbide and water circulated by revolving drill tube bit. Height, 41 in.; length, 28

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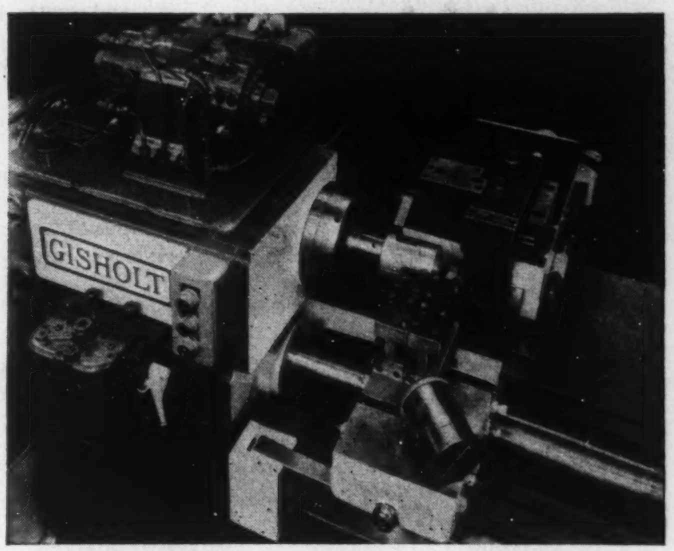
HOW TO DOUBLE PRODUCTION ON AN AUTOMATIC LATHE

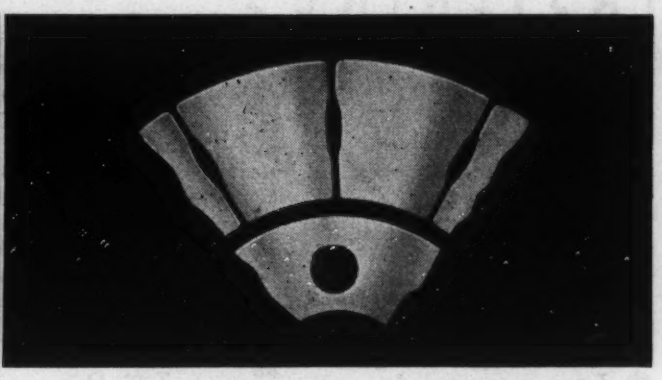
give it a Brake*!

*And the Brake to give it is a WARNER ELECTRIC INDUSTRIAL CLUTCH-BRAKE

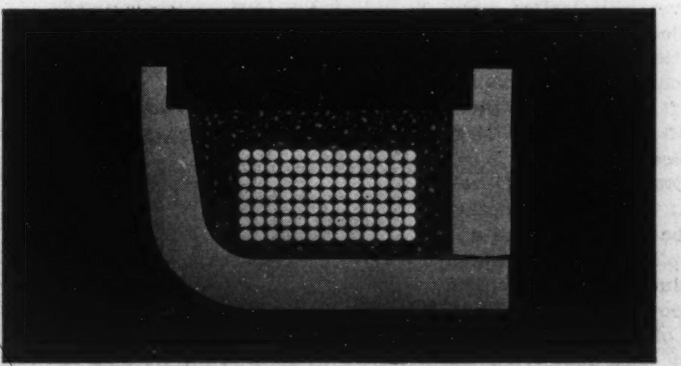


HERE'S HOW Gisholt does it on their No. 12 Hydraulic Automatic. Job: face, turn and cut off the riser on cast aluminum pistons. All starting and stopping of spindle is done by Warner Electric Clutch and Brake Units. Main drive motor is constantly running. Result: faster cycle operation — production doubled from 4 to 8 pieces per minute.

THE WARNER ELECTRIC INDUSTRIAL CLUTCH-BRAKE as mounted on a Gisholt No. 12 Hydraulic Automatic lathe. Note simple, compact mounting arrangement. Both units have only two parts. Ready accessibility of all clutch-brake parts means quick, easy maintenance however seldom required.



ARMATURE SECTION: One of only two parts for either Clutch or Brake units. Consists of magnetic segments welded to steel back-plate (see cut). Especially designed for high heat dissipation. Heat has no effect on unit efficiency because segment expansion is always linear . . . keeps full magnet contact at all times.



MAGNET SECTION: The other of the two parts for either Clutch or Brake units. Consists of electro-magnet faced with long-wearing, high friction material. Power, applied through coils imbedded below (see cut), applies friction *plus* magnetic attraction for fast, super-powerful clutch or brake action.

- Warner ICB Units* are low-cost key to more automatic, safer operation of wide variety of motors and machinery . . . give you infinite control of degree of clutch or brake action. For details or engineering assistance write: INDUSTRIAL DIVISION, WARNER ELECTRIC BRAKE MFG. CO., Beloit, Wis.

WARNER
ICB UNIT*

*ICB Unit — The trade designation for the Warner Electric INDUSTRIAL CLUTCH OR BRAKE UNIT.

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FASTENINGS
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- **2** Resistance to High Temperatures
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- **4** Non-Sparking
- **5** Re-Usable
- **6** Attractive Appearance
- **7** Easy to Clean
- **8** High Strength
- **9** Long Life
- **10** Lower Ultimate Cost
- **11** Resistance to Fatigue
- **12** Easy to Plate or Finish
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in., and width, 12½ in. Use of aluminum has reduced weight to 155 lb. Howe-Simpson Inc., Columbus, O.

WATER COOLER. Bottle type cooler has capacity of 3½ gph with room and bottle water temperature of 80 F. Water flow from bottle to faucet is through enclosed, stainless steel reservoir and tubing. Unit is 41 in. high by 16 3/16 in. square. Height to top of bottle, 56 in. Cordley & Hays, New York, N. Y.

AUTOMATIC WATER HEATERS. In oil or gas fired models. For supplying hot water for hotels, restaurants, apartments, etc. Heat output of oil-fired model, 93,000 Btu per hr. Gas-fired models available in 6 sizes with heat outputs of 36,000 to 126,000 Btu per hr. Automatic in operation. United States Radiator Corp., Detroit, Mich.

SPRAY WASHER. For cleaning of metal parts with ordinary alkali cleaning compounds or compounds that have tendency to foam excessively. Incorporates multiple wash, rinse and dry-off stages. Work is pressure-sprayed from spray headers; blow-off stage may be steam or gas heated or built for cold air blast. Chips removed from compound by screens before recirculation. Detrex Corp., Detroit, Mich.

AIR COMPRESSORS. Capacities; 60, 105, 160, 210, and 315 cfm at 100 psi. Features include aluminum alloy heads and manifolds, force-feed lubrication, and individual air cleaners for each low-pressure cylinder. Available in various mountings including skid, tractor and truck models. Davey Compressor Co., Kent, O.

POWER CONCRETE CART. Capacity, 2000 lb. Powered by 7-hp., 4-cycle gas engine permitting cart to climb 20 per cent grades with full load. Steered by tiller that enables machine to turn in 4-ft radius. Forward and reverse operation controlled by tiller, speed controlled by foot throttle. Basic tray holds 9 cu ft, sideboards increase capacity to 12 cu ft. Chain drive gives top speed of 10 mph. Gar-Bro Mfg. Co., Los Angeles, Calif.

SUPERCHARGED DIESEL ENGINE. Develops 225 hp at 1800 rpm. Engines have 5⅛-in. bore, 6-in. stroke and 743-cu in. piston displacement. Features include 2-valve heads, continuous-groove main bearings, buttress type oil pan and flywheel housing, newly designed oil cooler, and Roots type blower. Cummins Engine Co. Inc., Columbus, Ind.

AIR COMPRESSORS. In 7½, 10 and 15-hp units. Capacity of 10-hp model, 47.86 cfm at 175 psi. Compressor is of 4-cylinder balanced-vee de-

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sign, incorporating dynamically-balanced forged crankshaft. forged connecting rods with prefit bearings, ball type main bearings, ring and centrifugal force oiling, and removable cylinder blocks and valve assemblies. DeVilbiss Co., Toledo, O.

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PROFESSIONAL TAPE RECORDER. Magnetic type recorders for broadcasting studios, either portable or console models. Consists of 2 units, recorder and amplifier. Reels hold tape for 33 minutes of recording at 15 in. per second or 1 hour of recording at 7½ in. per second. Rewind of entire reel requires 3 minutes. Radio Corp. of America, RCA Victor Div., Camden, N. J.

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REFRACTOMETER. Portable. For testing and controlling quality of chemicals, foods and oils. Detachable prism system permits replacement of optics for repair to avoid down time. Includes built-in, corrosion-free glass scale, dust-proof housing and illuminated optical system. Bausch & Lomb Optical Co., Rochester, N. Y.

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PROCESSING MACHINE. Four-tank open-width machine has individual motor drive for each roll. Frames and roll standards are of mild steel, balance of machine made of stainless steel. Rolls either belt or direct driven. Cook-Pan Machine Co. Inc., Boston, Mass.

MICROSET PADDLER. New 100-in. model uses 2 stainless steel rolls and 1 rubber-covered roll. Includes stainless splash pans, self-aligning roller bearings, stainless guide rolls and rubber expander on entrance end. Other models available with center roll drive and pneumatic pressure, in widths from 50 to 110 in. Cook-Pan Machine Co. Inc., Boston, Mass.

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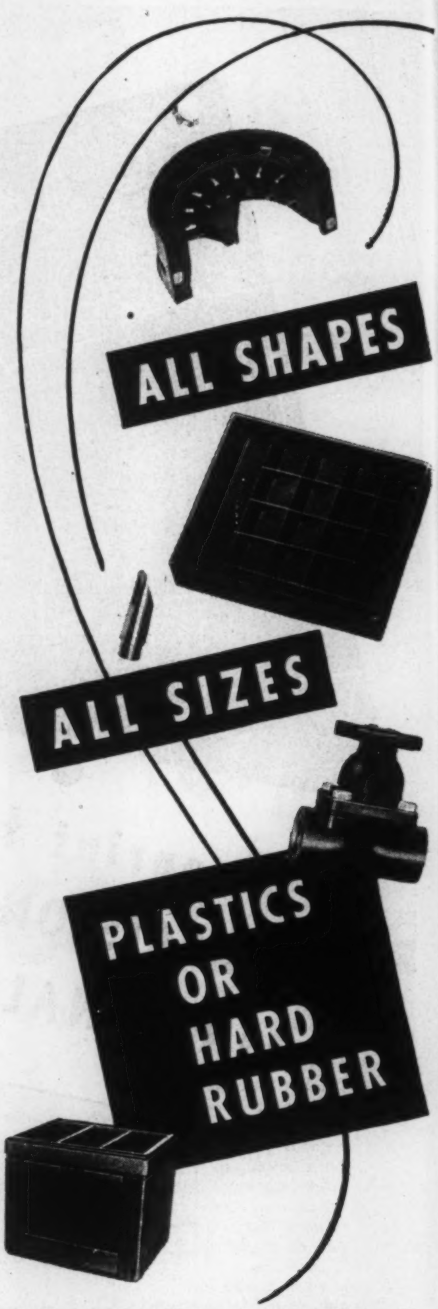

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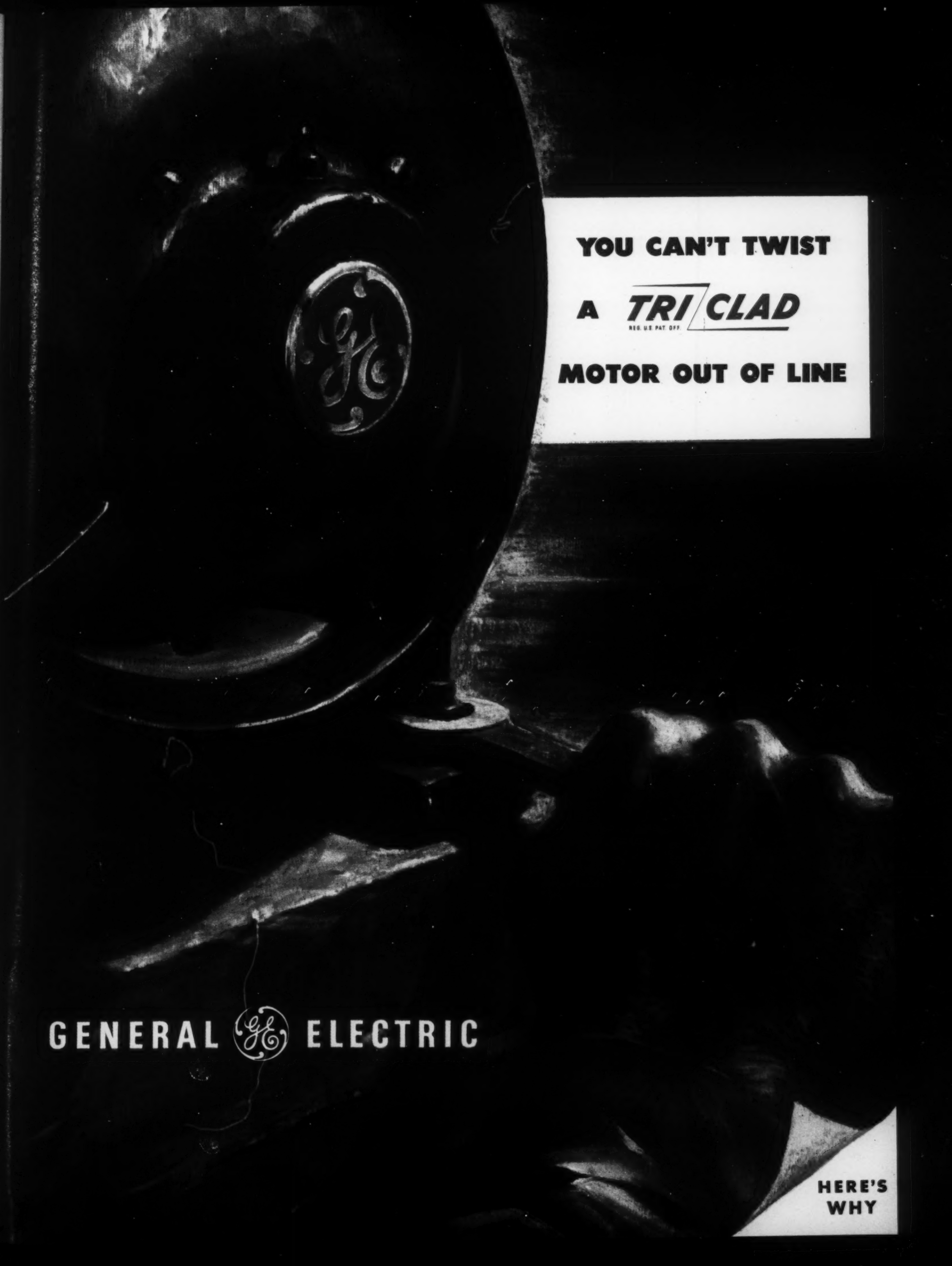
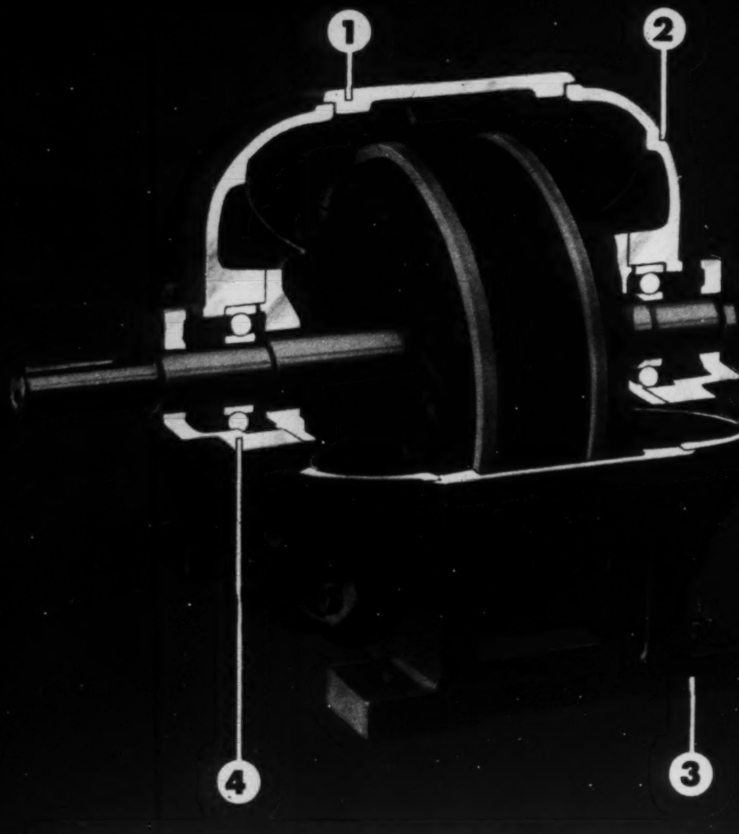


YOU CAN'T TWIST
A TRI/CLAD
REG. U.S. PAT. OFF.
MOTOR OUT OF LINE

GENERAL ELECTRIC

HERE'S
WHY



Look at the solidity of a Tri-Clad's thick-section cast-iron frame (1) and heavily reinforced end shields (2) . . . its heavy integrally cast feet (3). Do you wonder we say "Tri-Clad gives you structural strength and rigidity no other general purpose motor can match"? Notice, too, the *completely enclosed* bearings (4). A Tri-Clad motor will run safely without relubrication for years — as long as any general-purpose motor you can buy. Yet it's grease-gun easy to lubricate if you ever need to.

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Try as a heavy-muscled mechanic may, he can't twist a Tri-Clad motor frame when bolting it to an uneven surface. The bolt will snap before he can pull that rigid cast-iron structure out of line.

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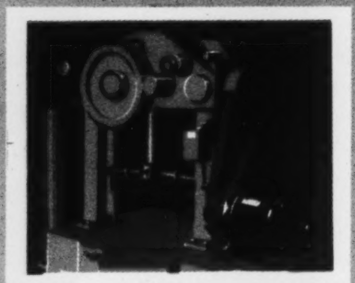
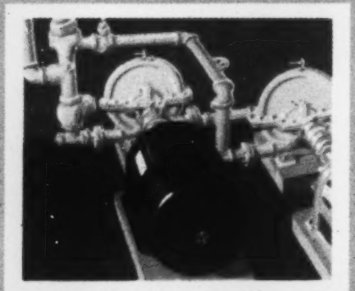


G-E open (dripproof) induction motors for constant-load, constant-speed applications. From 1 to 2000 hp.



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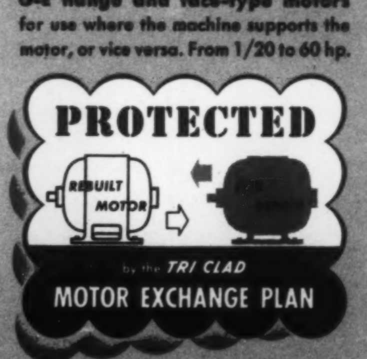

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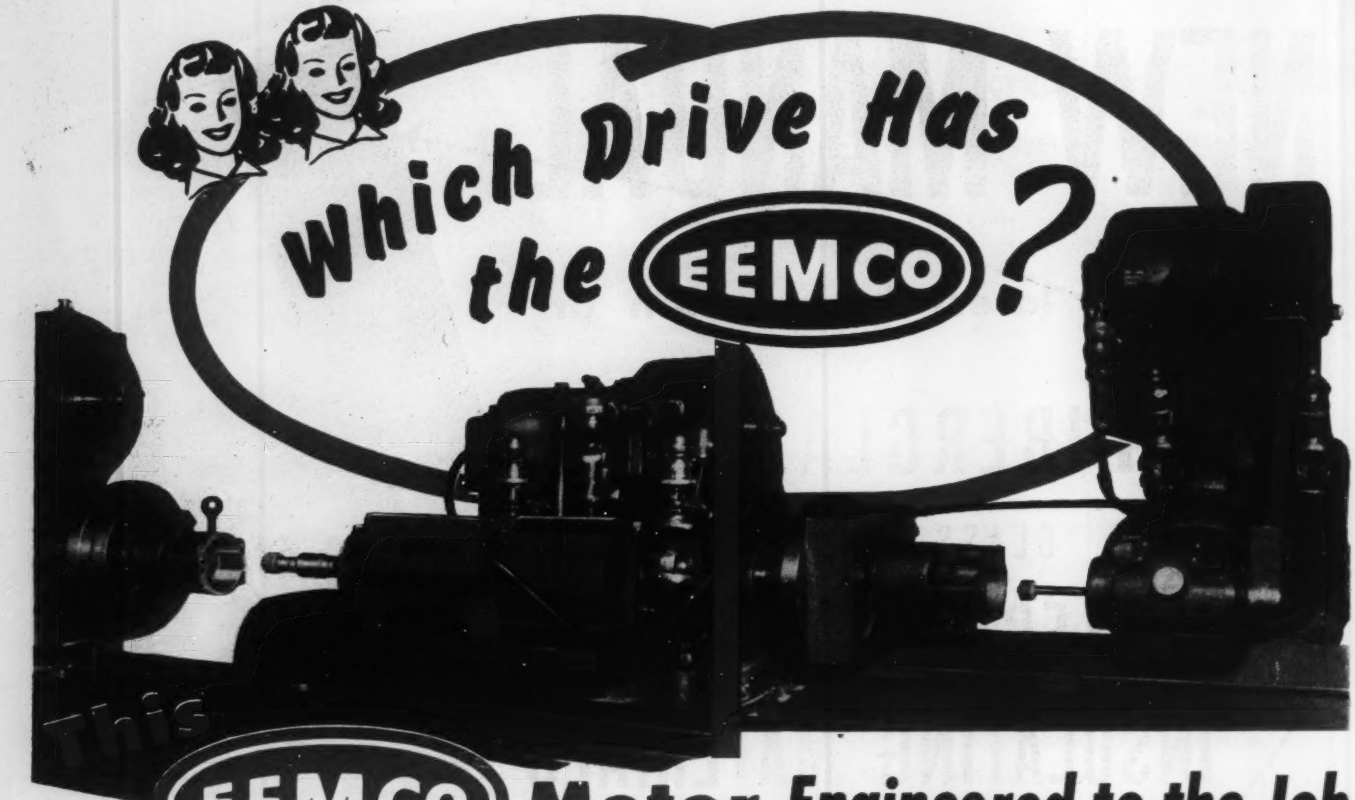

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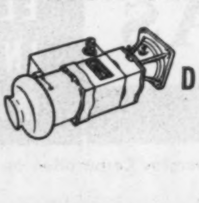
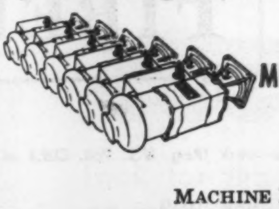

DEVELOPMENT

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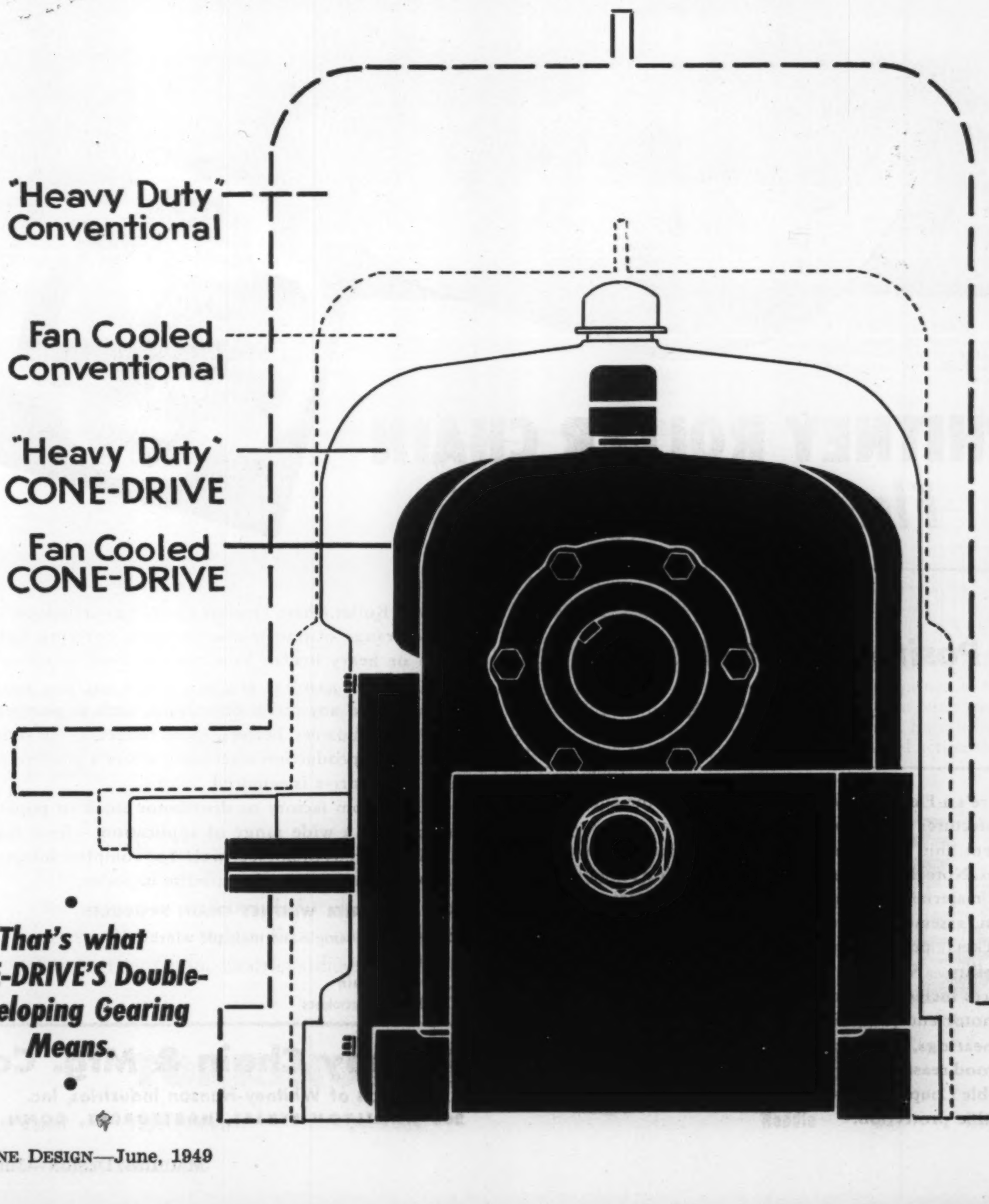
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"Heavy Duty" CONE-DRIVE
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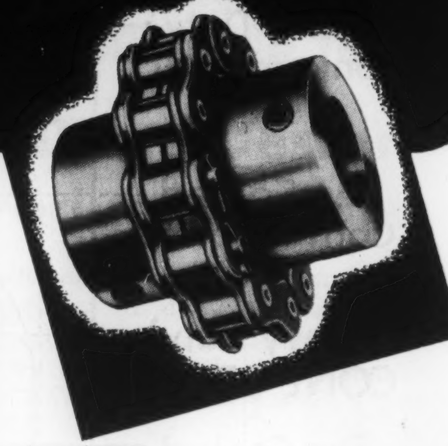
NEW! — Whitney Type A Flexible Coupling now features plastic covers for reduced weight and efficient high speed operation.



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Flexible Couplings

For
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Whitney Roller Chain Flexible Couplings are adaptable to a wide range of transmission service, covering light, medium or heavy loads. You can use them to connect electric motors, gasoline engines, diesel engines, steam engines, etc., to any direct drive units, such as pumpers, compressors, blowers, beaters, speed reducers,—in short, to any of your production machinery where a positive but flexible direct drive is required.

Available from factory or distributor stock in popular sizes covering a wide range of application — from fractional to hundreds of horsepower. For complete information and engineering bulletin, write us today.

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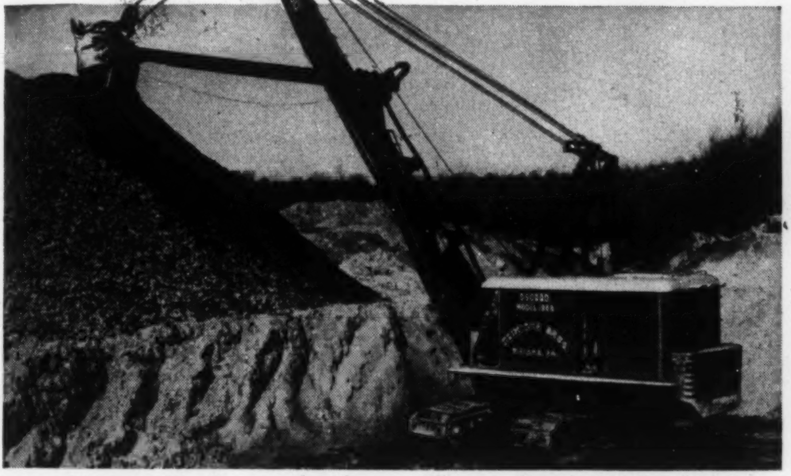
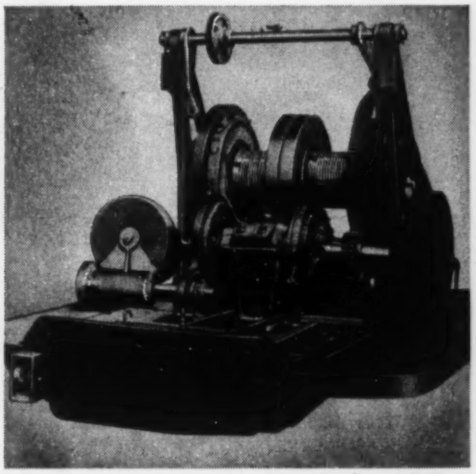
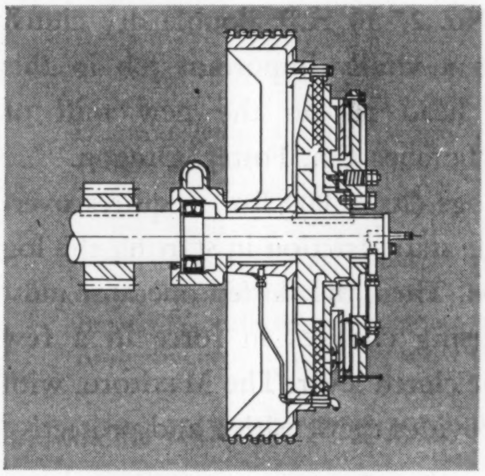
Torrington Spherical Roller Bearings Resist Shock Loads Effectively in Osgood Power Shovels



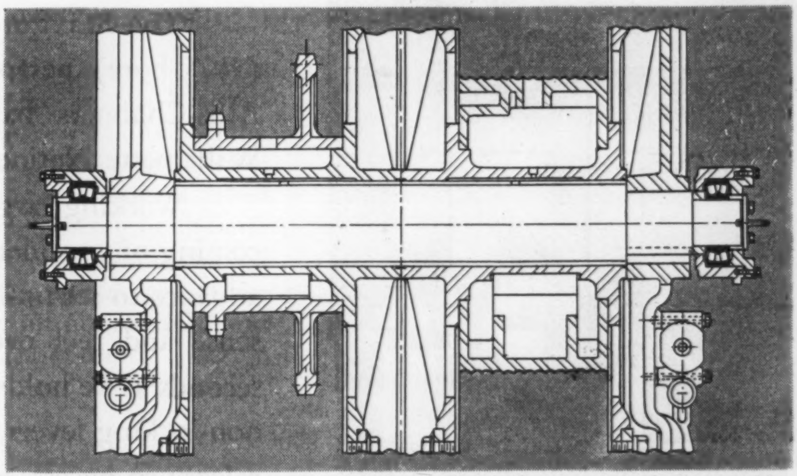
Osgood Power Shovels operate with power for crowding, hoisting and swinging transmitted smoothly on Torrington Spherical Roller Bearings. These self-aligning bearings provide the high capacity required for heavy excavating work and assure long service life. They run free and true even when shock loads cause shaft deflection or frame distortion.



In the working heart of the shovel, above, Spherical Roller Bearings are used on the reversing shaft and the hoisting drum shaft. Design advantages include accurate alignment on installation and axial stability of shafts.

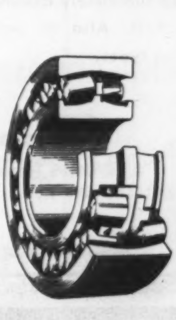


In the reversing shaft installation, shown here, hoisting pinion and bevel gears are held accurately in line, and operate with minimum wear. Spherical Roller Bearings carry the loads with an ample safety factor.



Cross-section of the hoisting drum shaft shows the design principle that enables Spherical Roller Bearings to compensate for deflection. The outer race bore is a section of a sphere, with its center at the axis of the bearing. Barrel-shaped rollers align automatically within this race. Smooth, efficient shovel action results under exacting service conditions.

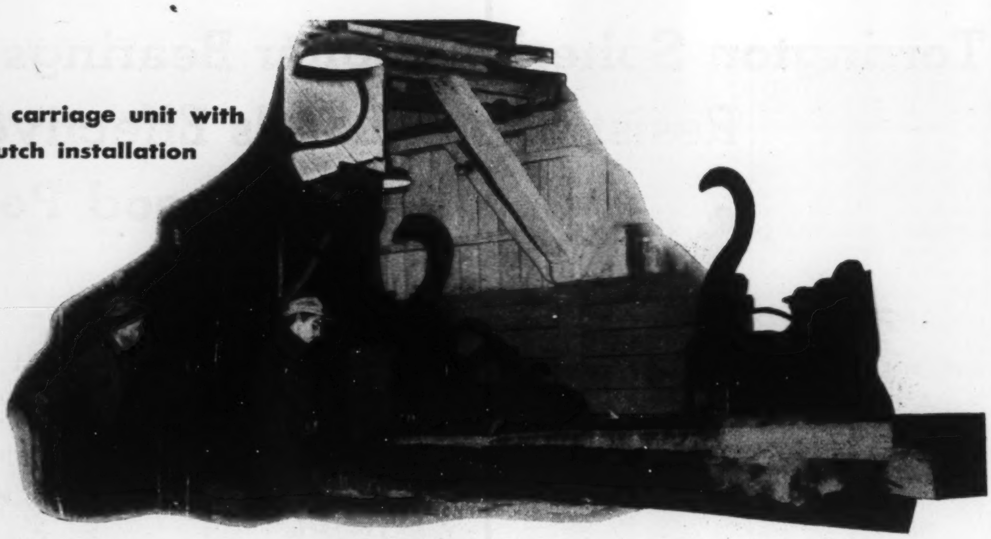
The reliable performance of Torrington Spherical Roller Bearings in heavy-duty equipment increases machine productivity and reduces maintenance. Our engineers will be glad to help you adapt them to your design requirements. Write us today. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities.



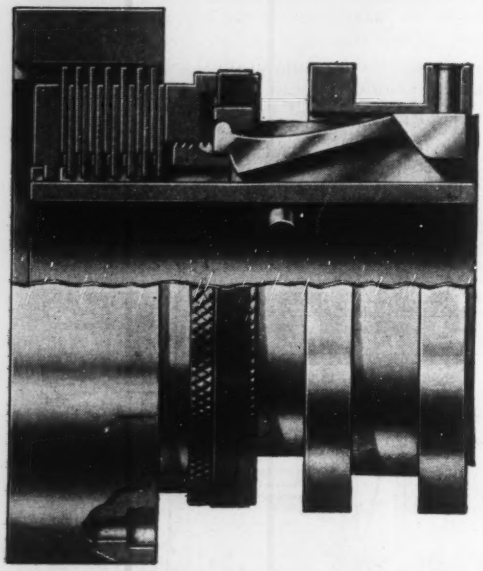
TORRINGTON *SPHERICAL ROLLER* BEARINGS

Spherical Roller • Tapered Roller • Straight Roller • Needle • Ball • Needle Rollers

ALLIS-CHALMERS saw mill carriage unit with Maxitorq Floating Disc Clutch installation



MAXITORQ



Capacities to 15 H.P. at 100 R.P.M. . . . single or double, wet or dry. Clutch shipped completely assembled ready to slip onto shaft. Also in pulley and cut-off coupling types.

. . . keeps Good Company

The Maxitorq No. 27 10 H.P. double dry clutch (2¾" bore) performs a vitally important job in this Allis-Chalmers band head rig in the new mill of Willamette National Lumber Co., Foster, Oregon.

Working large logs (to 35,000 lbs.) requires overcoming of considerable static friction in starting the log advance to set position. Then, the skilled operator must sense and feel decreasing changes in force in a few seconds as he holds the clutch lever. The Maxitorq, with non-locking levers, provides the sensitive and protective release so necessary.

Maxitorq was selected by Allis-Chalmers when other units proved unsatisfactory . . . and naturally we are proud to be in such "good company." Can we help you?

Send for Catalog No. MD6

3CJ49

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H TYPE MAGNETO

No magneto manufacturer in the world can refer to greater or broader experience in this field than the Scintilla Magneto Division. Therefore, when we present the new Bendix-Scintilla H-type magneto as the finest of its kind, we are on solid ground. A careful check of the distinctive features listed below—each of which carries definite engineering significance—should confirm our claim of better performance for all single cylinder engines. Look into the advantages of the Bendix-Scintilla H-type magneto now; for full specifications contact your distributor or write the factory direct.

Flange Mounted H-Type Magneto

OUTSTANDING FEATURES YOU'VE ASKED FOR

- **Waterproof Coil**
- **Waterproof, high-tension outlet**
- **Higher voltage at starting speeds**
- **Constant spark over entire speed range**
- **Equipped with impulse coupling**
- **Compact and sturdy construction**

Base Mounted H-Type Magneto

SCINTILLA MAGNETO DIVISION of

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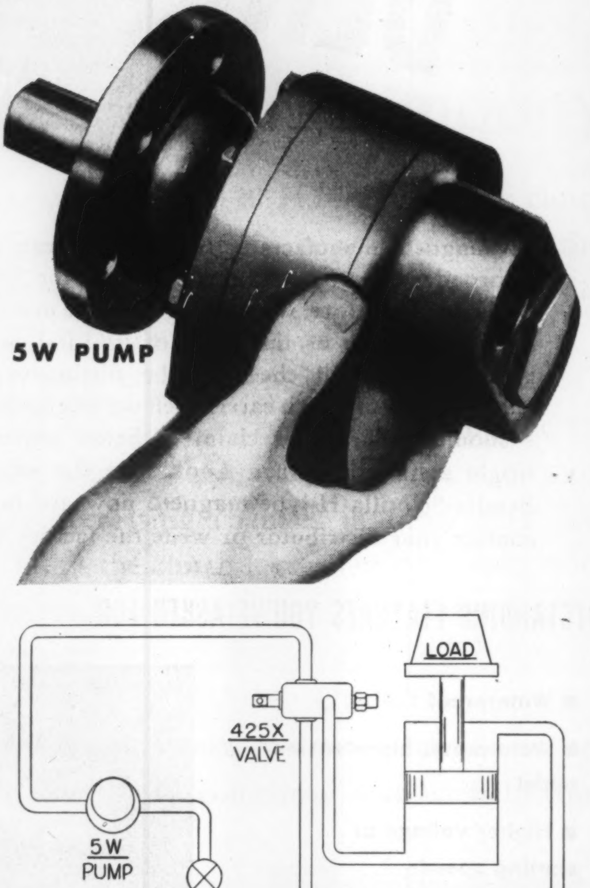
SIDNEY, NEW YORK

IF YOU ARE DESIGNING LIFTING MECHANISMS WITH GRAVITY RETURN . . .

Here's a Hydraulic Valve and Pump Combination that Gives You *"ACCELERATOR-CONTROL"* Where You Want It— *AT LOWER COST*

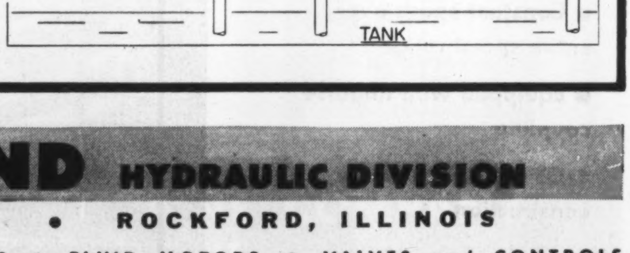
425X VALVE


5W PUMP

Use this low cost combination of a Model 5W pump and 425X valve on any design requiring an efficient lifting mechanism. The pump can be placed in the ideal driving position and the valve at point of most convenient operation.

The 5W Sundstrand pump incorporates the Rota-Roll principle and pumping members which produce more efficient inlet port conditions, a reduction in cavitation, a quietly operating pump and longer pump life. It is a low cost pump available in seven capacities ranging from 4 to 10 gpm at 1200 rpm. The 5W pump is suitable for 1200 psi service.

The Sundstrand 425X valve gives you "accelerator-control" and can be placed in any convenient operating position on your design. It is a spring centered three position valve to raise, hold and lower and incorporates a built-in relief valve. It produces a throttling action when loading and unloading cylinder. Its stem is arranged for connection to practically any type of mechanical linkage. It is simple to install and has all porting clearly marked.



FREE ***Additional Data*** Get complete facts and additional features on this efficient combination. Ask for Bulletin M-42.

SUNDSTRAND HYDRAULIC DIVISION

2559 ELEVENTH STREET • ROCKFORD, ILLINOIS

FUEL UNITS • HYDRAULIC PUMPS • TRANSMISSIONS • FLUID MOTORS • VALVES and CONTROLS

FASTER LOADING

Another COST-CUTTING Application of VICKERS Hydraulics

ATHEY Model 3 FORCE-FEED LOADER
SELF-PROPELLED

One important reason why users of the Athey Force-Feed Loader report savings in time and money is because it is equipped with Vickers Hydraulic Controls. A Vickers Multiple-Unit Valve is used to raise and lower the moldboard, throat, feeder and conveyor. Hydraulic power is supplied by a Vickers Balanced Vane Type Pump driven from the engine crankshaft pulley.

The Vickers Sectional Type Multiple-Unit Valve, available in many combinations for operating single- or double-acting cylinders, provides convenient and selective control. Ask for Bulletin 40-13.

Vickers Balanced Vane Pumps are outstanding for their long life and efficient operation. Their exclusive hydraulic balance construction entirely eliminates pressure-induced bearing loads and resulting wear. Longer life and less hydraulic slip are insured at maximum operating pressures. Ask for Bulletins 36-12 and 49-52.

3823

VICKERS
MULTIPLE-UNIT
VALVE
VICKERS
BALANCED
VANE TYPE
PUMP

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION
1430 OAKMAN BLVD. • DETROIT 32, MICHIGAN

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

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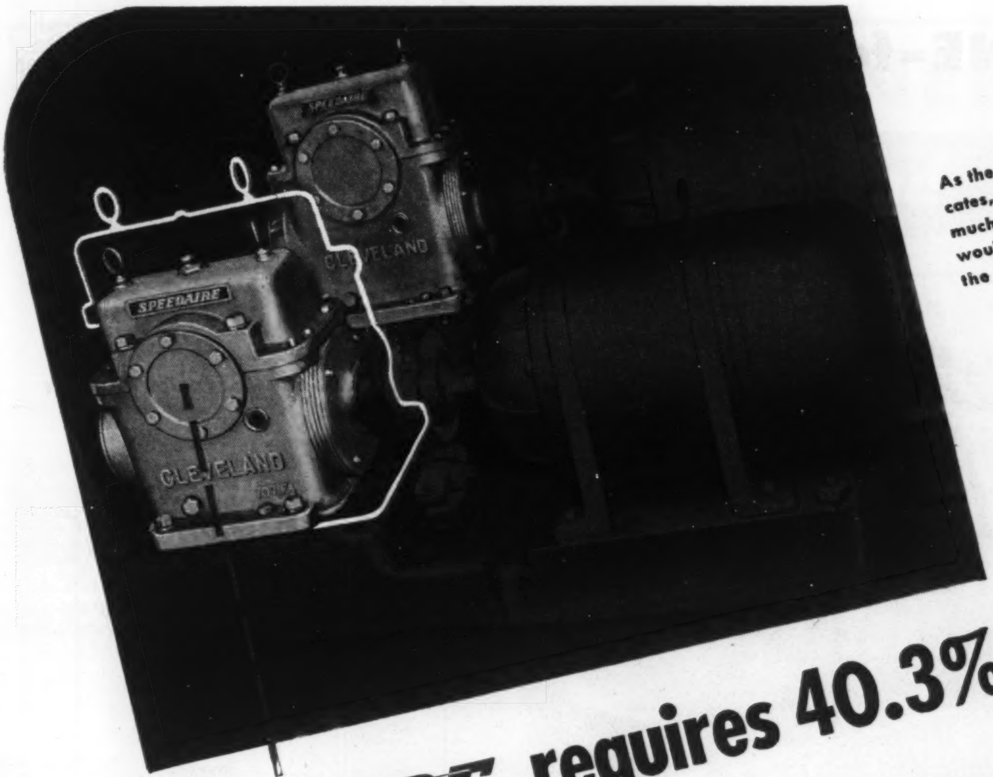


As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

SPEEDAIRE requires 40.3% less space

HERE are two of six Speedaires driving grain elevators in a new rice drying plant in Arkansas.

Three important savings led the rice growers association to install Speedaires rather than conventional worm-gear drives: First, use of Speedaire cut down the space required for the installation by 40.3%. Second, Speedaire reduced the load on the floor 25%. Finally, the company saved $279 in the initial cost.

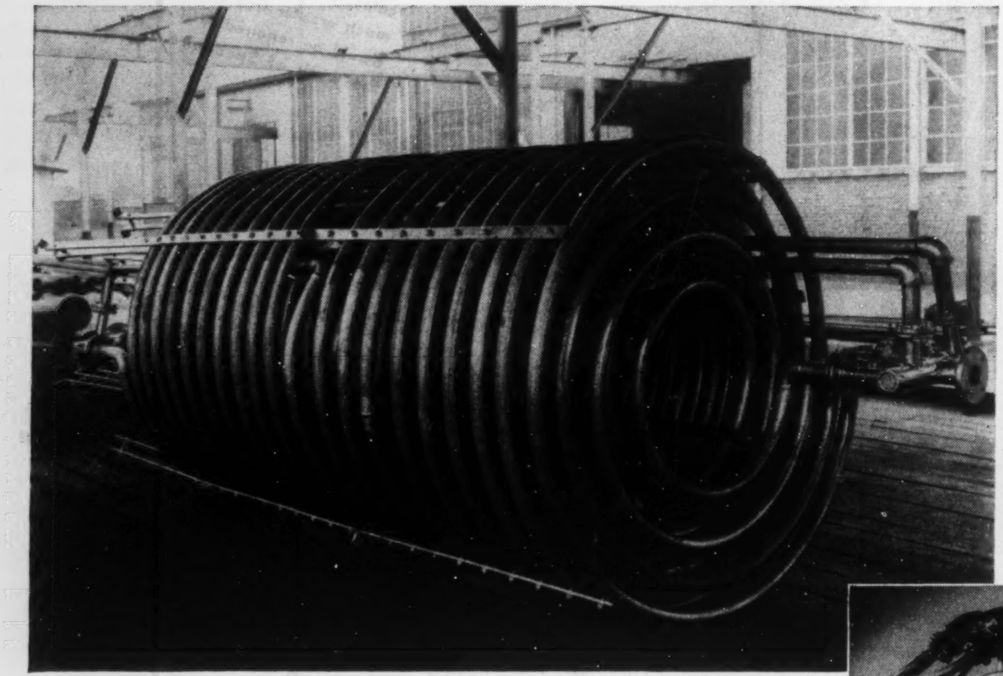
Speedaire is Cleveland's fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3265 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication.
In Canada: Peacock Brothers, Limited.

CLEVELAND
Worm Gear
Speed Reducers

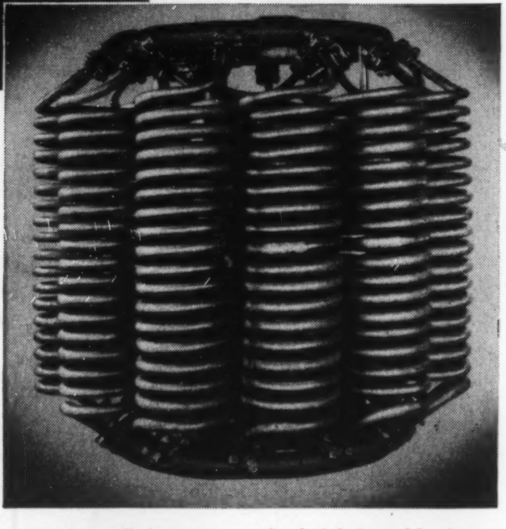
Why CRANE-fabricated pipe coils are the finest available



ONE

SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Unusual assembly *of Multiple Cylindrical Pipe Coils. Fabricated header specially designed for terminal connections.*



17 pipe coils in one—*completely fabricated by Crane.*

The explanation is simple enough. Crane is the world's foremost designer and fabricator of industrial piping equipment. Five Crane Shops, strategically located throughout the country, offer you the special facilities needed for fabricating pipe coils to precise requirements.

No pipe coil design is ever too large or small . . . or too complex . . . for Crane Shops to handle. Skilled manpower and superior equipment combine to assure efficient fabrication of practically every size, shape and type of tubular material.

Pipe coils of uniform accuracy and quality are as near to you as your Crane Branch or Wholesaler. You get complete local service. Talk it over with your Crane Representative.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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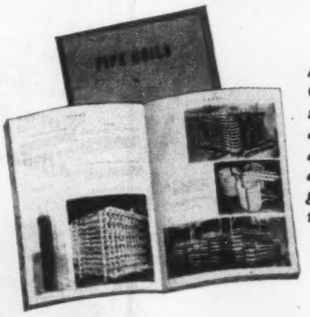

Ask your Crane Man *for Pipe Coil Catalog 318—48 pages of helpful information for pipe coil specifiers and buyers. Includes diagrams of all common pipe coil designs with dimensions, and gives valuable engineering data on pipe coil materials and applications.*

EVERYTHING FROM . . .

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PLUMBING
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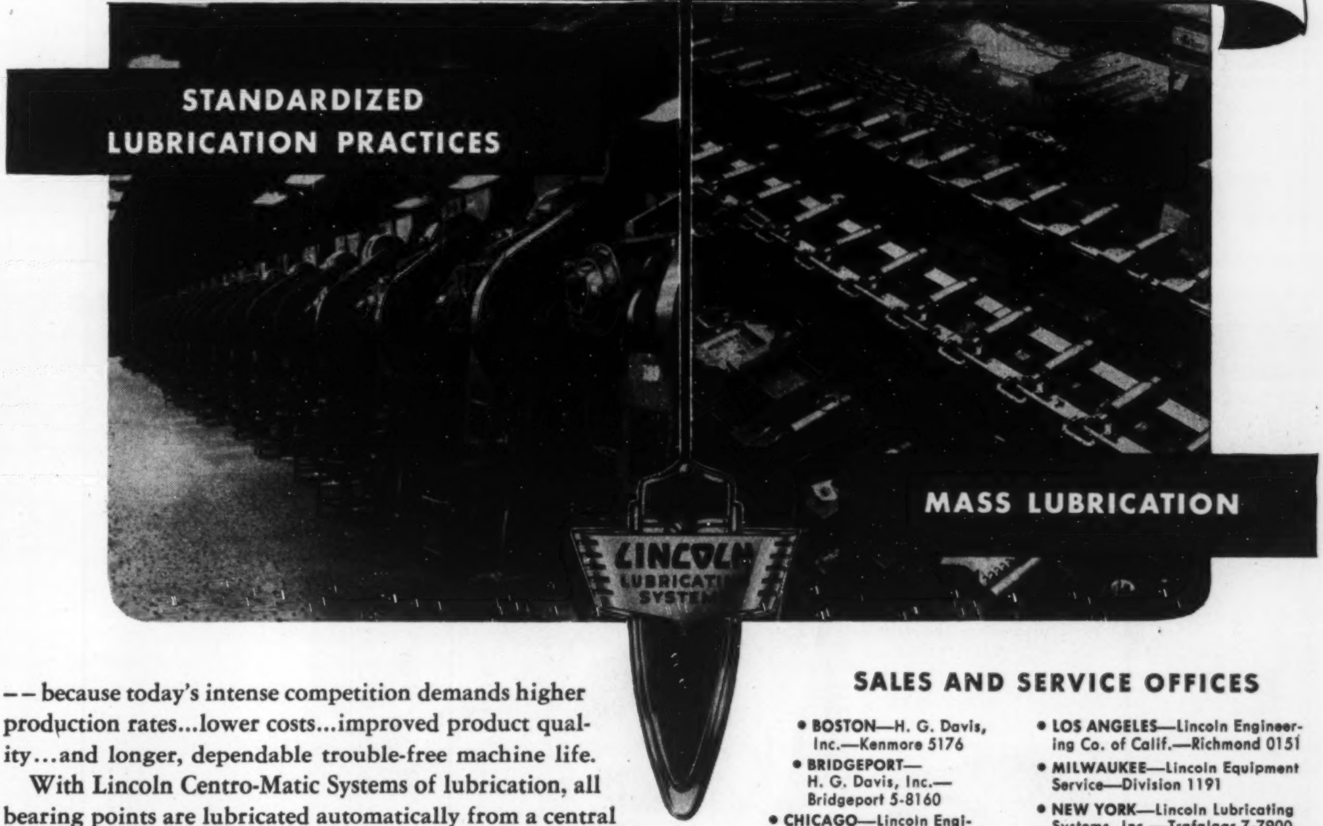
FOR EVERY PIPING SYSTEM

DESIGN ENGINEERS

Must Understand

MODERN LUBRICATION METHODS



-- because today's intense competition demands higher production rates...lower costs...improved product quality...and longer, dependable trouble-free machine life.

With Lincoln Centro-Matic Systems of lubrication, all bearing points are lubricated automatically from a central source and groupings of similar machines are lubricated simultaneously as part of one standard system of lubrication—insuring continuous, dependable machine performance, high production rate, improved product quality... free of costly repairs and downtime, excessive indirect labor and power consumption. Because adequate lubrication is so essential to lower operating costs, more and more machinery manufacturers are installing Lincoln Centro-Matic Lubricating Systems on the machines they are building. These Lincoln Systems insure precise application of clean lubricant with ease and speed and at predetermined intervals and in predetermined quantities. They deserve the most serious consideration of the designing engineer responsible for modern day machine tool efficiency.

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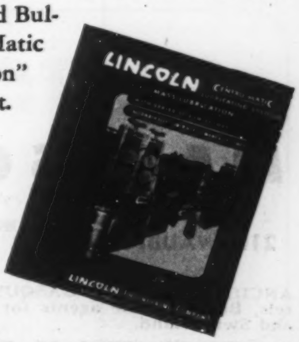
Your distributor will be glad to give you complete information or contact the Lincoln Sales and Service Office nearest you. Illustrated Bulletin — "Lincoln Centro-Matic Systems for Mass Lubrication" will be sent upon request.



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Bullneck Surface Check Grease Fitting . . . the modern fitting with the ball in the top.

LINCOLN

Builders of complete Lubrication Systems for a quarter of a century

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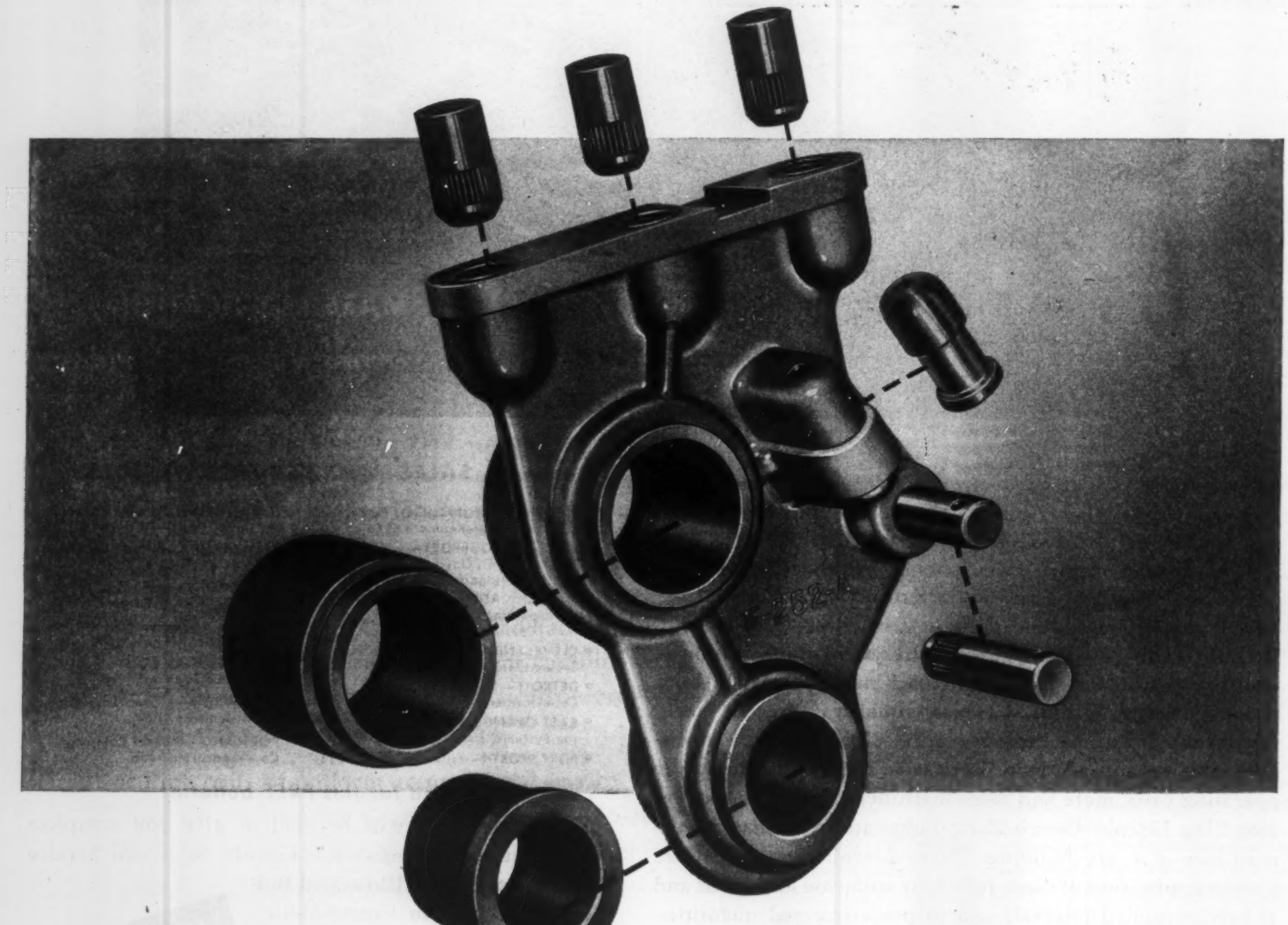
You may be able to reduce costs or add value to your product with iron, steel or brass inserts in Madison-Kipp zinc or aluminum die castings.

Please address all inquiries to the home office at Madison, Wisconsin.



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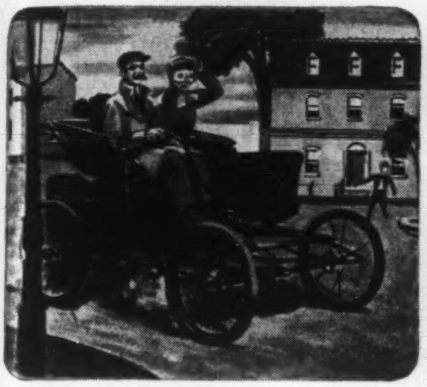
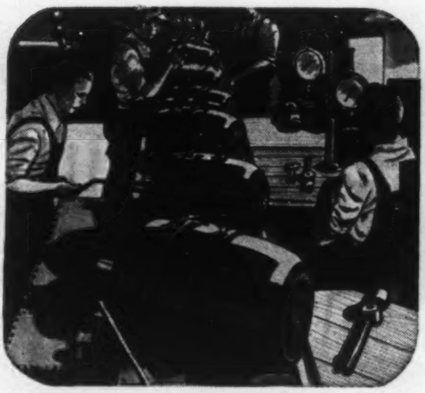
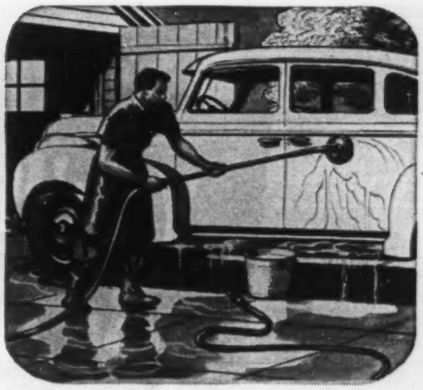


1 **1897**—America's first cars, hand-built and expensive, looked like this. Big questions of the day were—will it run? can I ever afford to buy one? Little thought was given to washing a car.

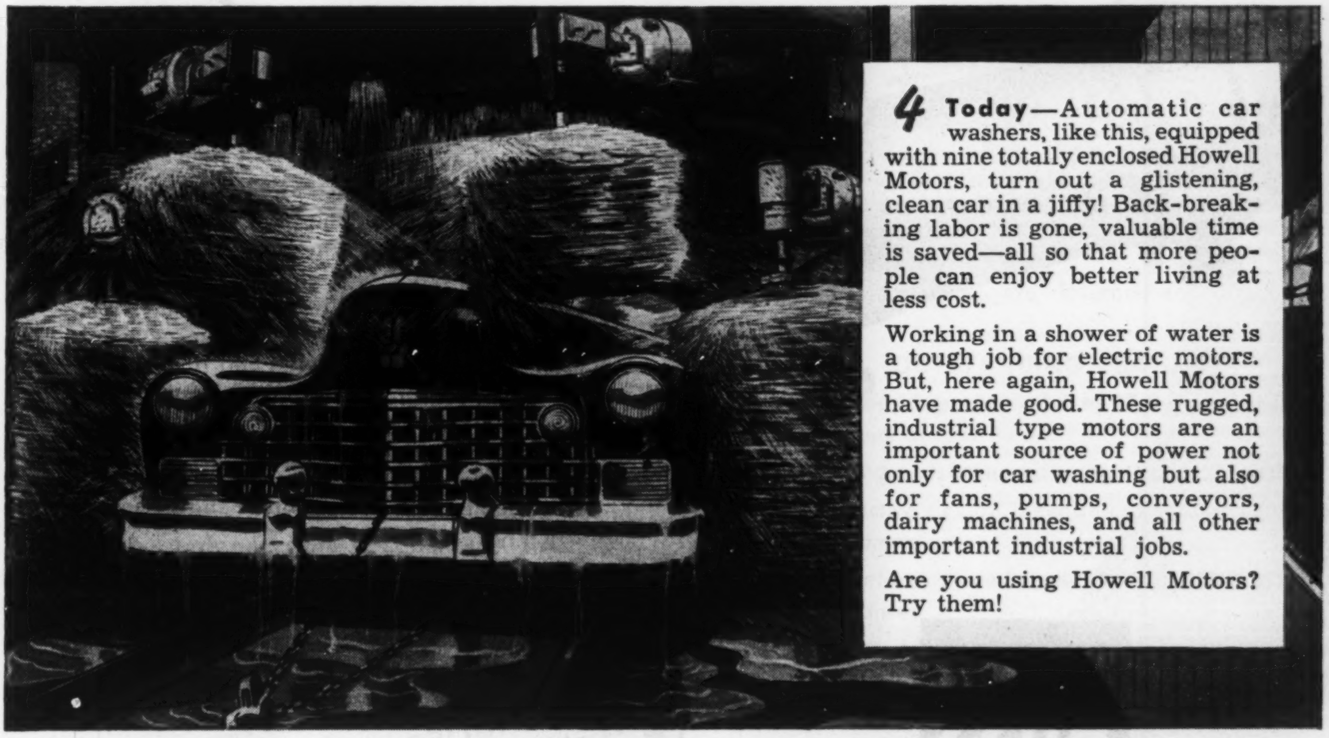


2 **1915**—Howell "Red Band" Motors arrived. The electrical horsepower age was already under way. Automobiles, as well as other goods and services, were soon to be better, cheaper.



3 **1935**—This combination brush and spray was one of many early car-washing devices. It wasn't until 1945 that modern assembly line methods began to be applied to the washing of cars.

NOW, A WASH WHILE YOU WAIT!



4 **Today**—Automatic car washers, like this, equipped with nine totally enclosed Howell Motors, turn out a glistening, clean car in a jiffy! Back-breaking labor is gone, valuable time is saved—all so that more people can enjoy better living at less cost.

Working in a shower of water is a tough job for electric motors. But, here again, Howell Motors have made good. These rugged, industrial type motors are an important source of power not only for car washing but also for fans, pumps, conveyors, dairy machines, and all other important industrial jobs.

Are you using Howell Motors? Try them!

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.

Howell totally enclosed motor built for operation in high humidity atmosphere. Remember, there's a Howell Motor for *every* industrial job.

Howell Enclosed or Splash-Proof Motor

HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.
Manufacturers of Quality Industrial Type Motors Since 1915

You'll transfer more BTU's per dollar invested...

...than with any other exchanger

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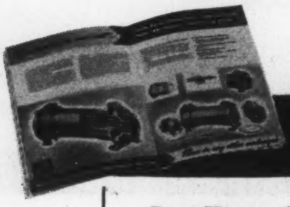
Oil and water cooling, water and process heating or vapor condensing requirements can now be met by units carried in stock as shelf goods at the Ross plant. The needs of *most* have been interpreted and placed into mass production. Low unit costs, which mean more BTU's transferred per dollar, await chemical, process, hydraulic machinery, Diesel, food, petroleum, paper, power, textile, metal and a host of other industries.



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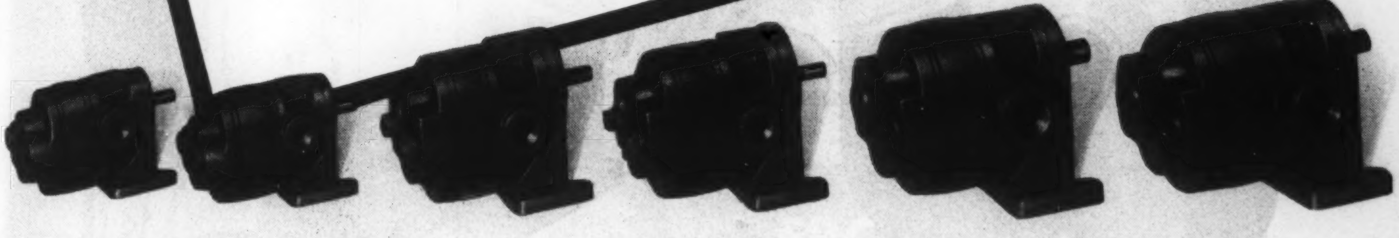

500 Series Hydraulic Pumps to fit your needs

Improve the efficiency and dependability of your hydraulic systems by selecting a pump best suited to the specific job.

Among the wide variety of pumps offered by Brown & Sharpe for hydraulic systems is the 500 Series. These pumps operate at especially high efficiencies and are long-lived and reliable. Equipped with herringbone gears of heat treated steel, these pumps run quietly at high speeds under pressures up to 500 lbs. p.s.i. Their speed characteristics are designed for direct motor drives.

OUTSTANDING FEATURES

- 6 sizes. Capacities—5.1 to 37.6 g.p.m. at 0 lbs. pressure at 1140 R.P.M.
- Moving parts balanced hydraulically for end thrust.
- Distinctive design mechanical seal requires no adjustment.
- All surfaces ground to oil-tight fit and held to close tolerances.
- Flange stand available to meet practically every mounting condition. Facilitates assembly of duplex and motor driven units.
- Direction of rotation easily changed.

These and other design and construction features contribute to top performance records established by the Brown & Sharpe 500 Series Pumps. Count on them to help make your hydraulic systems efficient, dependable and economical. Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

We urge buying through the Distributor

PUMPS FOR MANY APPLICATIONS

BROWN & SHARPE
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Brown & Sharpe pumps provide reliable means for circulating liquid for coolant purposes, for lubrication and for many other installations in addition to hydraulic. The complete line is shown in the latest pump catalog. Write for a copy.

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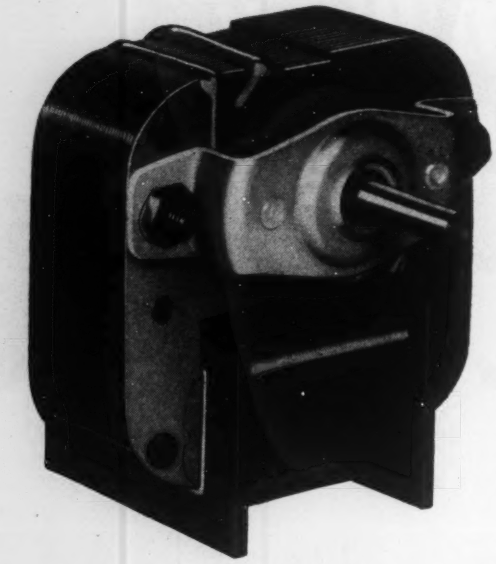

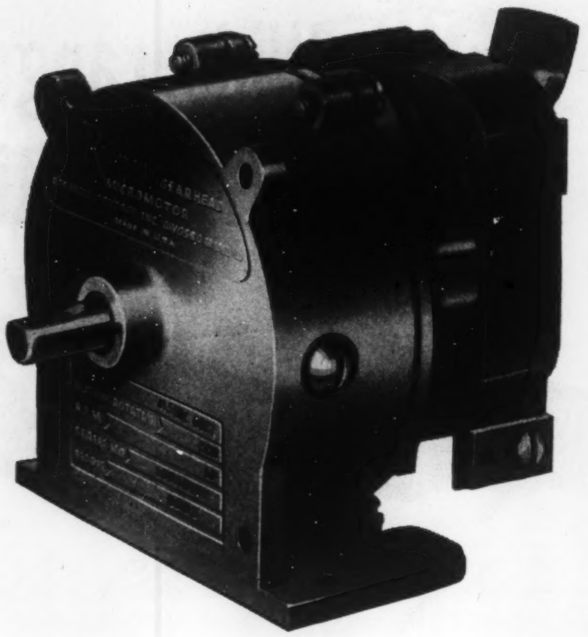

HERE ARE TWO NEW

Redmond MicroMotors

2-POLE OFFSET MicroMotor

Here's a low cost, skeleton-type Micromotor that is a rugged performer. This 2-pole offset unit is ideal for use in small room heaters, fans, animated displays, and other applications calling for light weight, low power motors. Features include air gap concentricity, sturdy bearing brackets, oil reservoirs packed with felt, and highest quality enameled windings. Two holes in field laminations facilitate mounting. Built in sizes up to 1/100th horsepower.

GEARHEAD MicroMotor

This sturdy, quiet-running gearhead unit is for applications requiring unusual r.p.m. specifications. Output selections are almost without limit down to 2 r.p.m. It is powered by a dependable Redmond 2-pole offset Micromotor with a single bearing lubricated from the gear box. Brake device can be supplied if required. Four mounting holes are provided horizontal to shaft on front surface and four vertical to shaft on base surface.

***Redmond* COMPANY, INC.**

OWOSSO, MICHIGAN

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OVER 150
STANDARD MODELS
25
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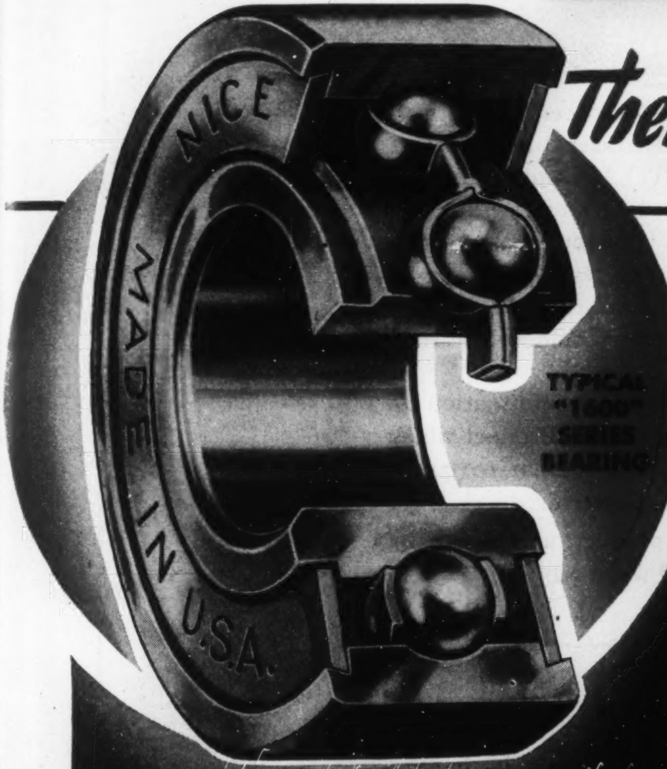
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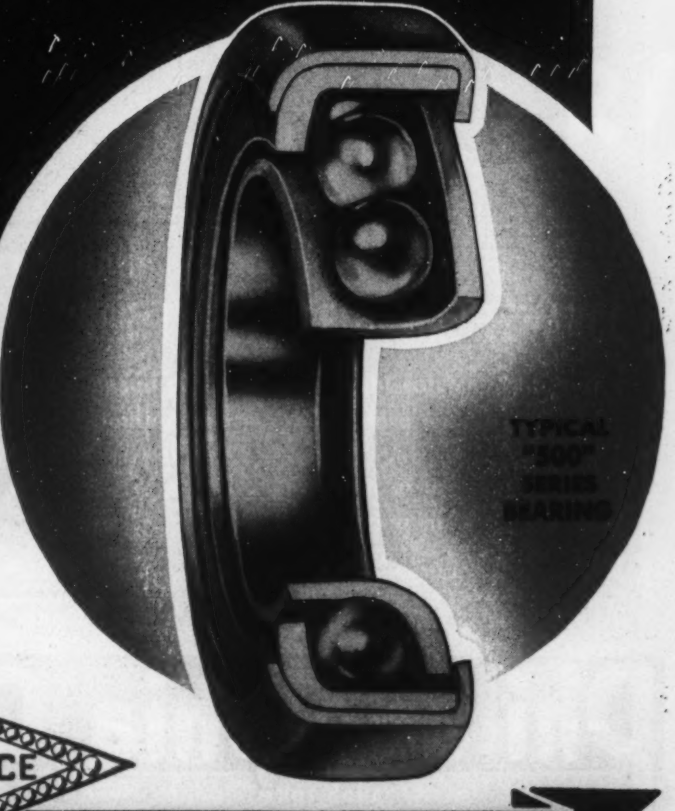
TYPICAL "1600" SERIES BEARING

FROM high quality, close tolerance "ground all over" Precision Ball Bearings. . . . .

TO low cost "unground" Ball Bearings of inexpensive design and construction.


TYPICAL "500" SERIES BEARING

Have you any Ball Bearing requirements on which we may quote? For complete information on the Nice Line write for Catalog No. 125.

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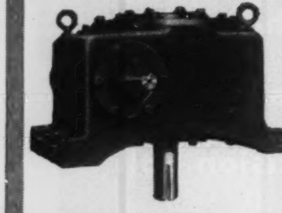
IT PAYS TO MAKE "ONE MANUFACTURER"

RESPONSIBLE FOR ALL YOUR GEARS AND SPEED REDUCERS

PHILLIE GEAR

Herringbone Reducer


Vertical Worm Reducer

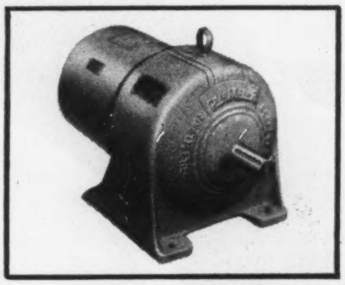
Worm Reducer

Limitorque Valve Operator

We design and manufacture *"every type and size"* of Gear and Speed Reducer . . . This fact is *important* because: (1) It assures the purchaser of our "unbiased" recommendations; (2) Permits ordering from "one source" of supply; (3) Enables the purchaser to place the *responsibility* for the operation of their Gears and Speed Reducers upon the shoulders of "one manufacturer."

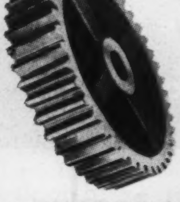
Your inquiries are invited for information on any type of Gear or Gear Driven Product which includes the widely used *"Limitorque" Motor-Operated Valve Control.*

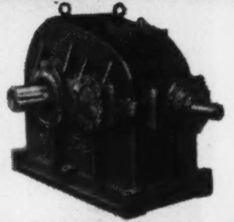
Send for catalog on any product, and please use your Business Letterhead when requesting same.

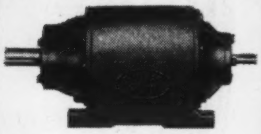

Philadelphia GearMotoR

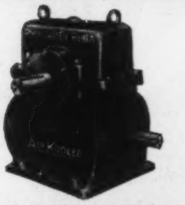
Continuous Tooth Herringbones up to 60" diameter. Separated Tooth Gears up to 150" diameter.

Worm Gears up to 150" diameter. Worms to match.


Spur Gears up to 150" diameter. Larger Gears in bolted sections.


Spiral-Bevel Reducer


Planetary Reducer


"AirKooled" Worm Reducer

Vertical Motor Reducer

Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

ATLAS...PROGRESS...QUALITY ...DELIVERY!

ON NEW RING-FASTENED ROLLER CHAIN OFFERING GREATER SAFETY . . . LONGER LIFE . . . LESS MAINTENANCE

Now! Atlas Detachable Roller Chain—well known for its high flexibility, durability, and strength—offers chain drive users everywhere a new improvement in roller chain. It's the new *ring-fastened* construction . . . saving time, money, and trouble in replacing conventional fasteners which often bend, shear, or fall out entirely. If struck by a direct blow, this new ring merely turns in a groove on the pin, hugging it tightly.

Atlas *ring-fastened* roller chain makes chain drives a lot safer. It has no dangerously exposed points which might catch onto a man's clothing and pull him into a machine.

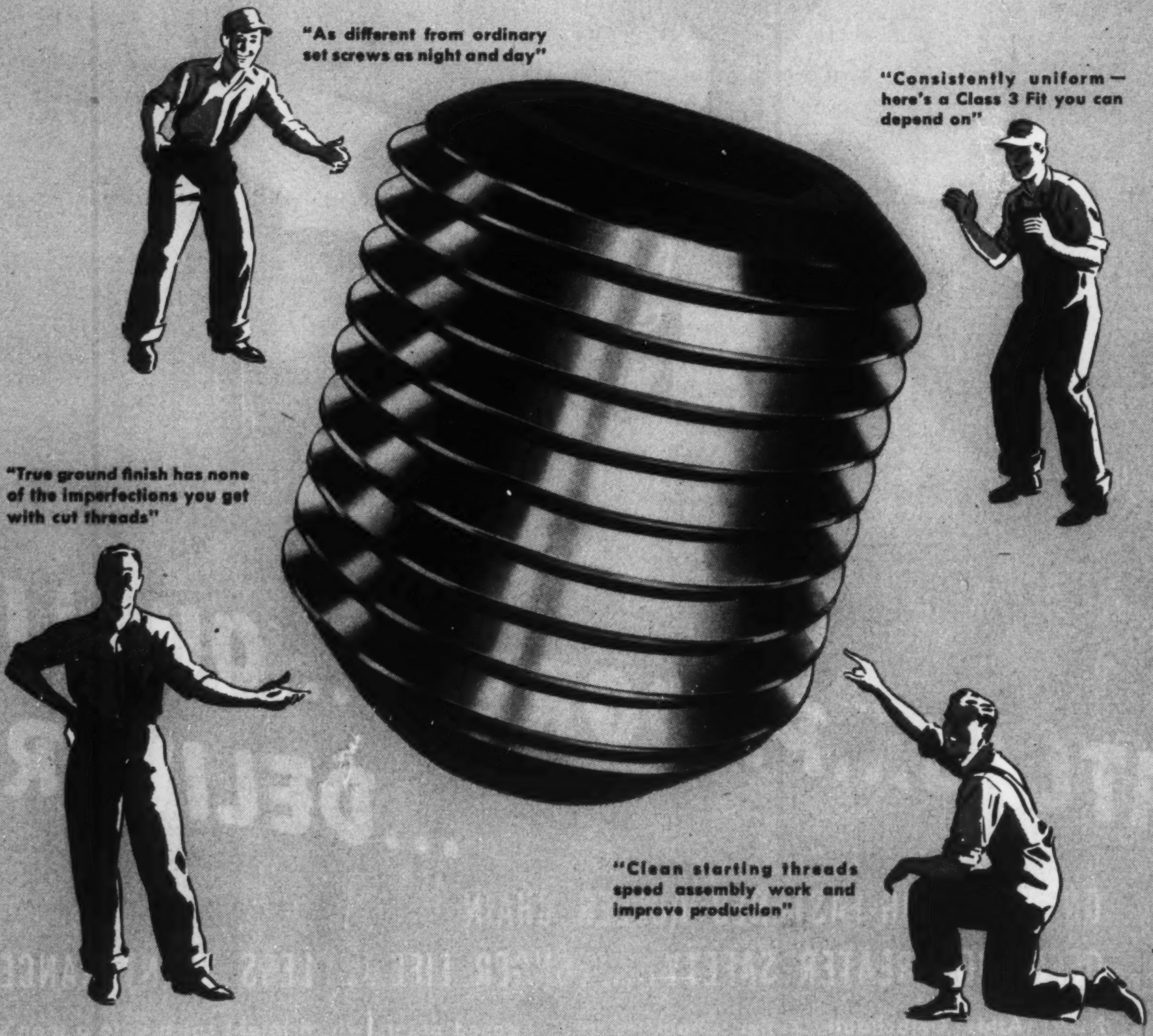
Removal and installation of the ring are easy and fast. Although the ring maintains a tight groove tension under all operating conditions, it is still springy enough to allow spreading any number of times without taking a permanent set.

Find out the details on Atlas' *new ring-fastened* roller chain by writing Atlas today. Ask for our new catalog: "Atlas Roller Chain."

ATLAS CHAIN AND MANUFACTURING CO.

Castor and Kensington Avenues, Philadelphia 24, Pa.

Parker-Kalon **GROUND THREAD** Socket Set Screws are **The TALK of the SHOP!**


"As different from ordinary set screws as night and day"
"Consistently uniform — here's a Class 3 Fit you can depend on"
"True ground finish has none of the imperfections you get with cut threads"
"Clean starting threads speed assembly work and improve production"

Compare! Write for Samples!

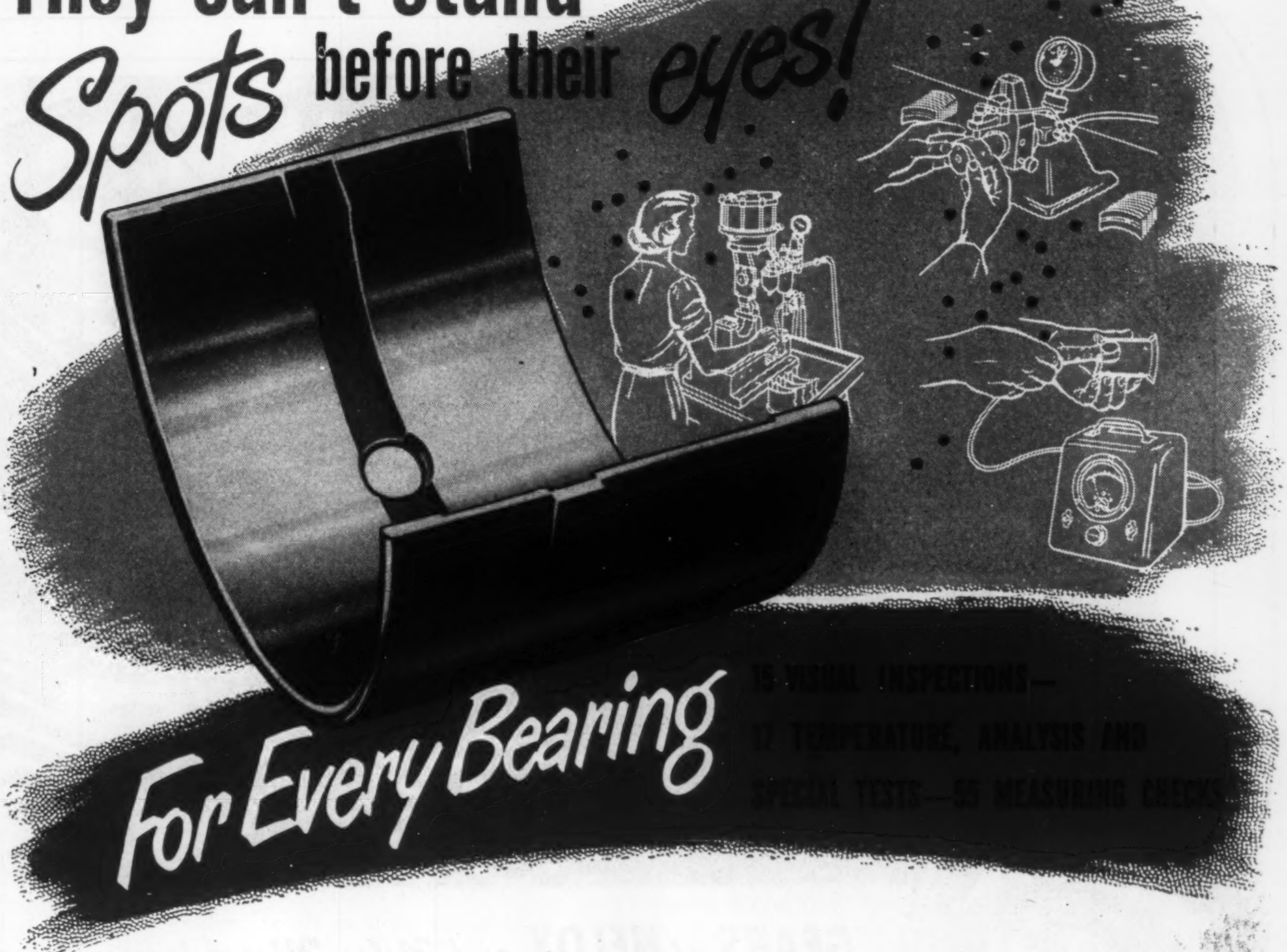
See why P-K Ground Thread Socket Set Screws speed assemblies, improve strength and safety. Thread grinding, once reserved for screws used in the finest precision equipment, now gives Parker-Kalon Socket Set Screws the accurate finish and faultless contour that mean faster assembly and more sales for your products. Write for samples today.

AVAILABLE FOR PROMPT DELIVERY

PARKER-KALON® CORPORATION
200 Varick Street
New York 14, N. Y.

SOLD ONLY THROUGH ACCREDITED DISTRIBUTORS

They can't stand *Spots* before their *eyes!*



For Every Bearing

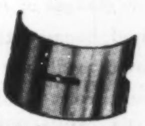
15 VISUAL INSPECTIONS—
17 TEMPERATURE, ANALYSIS AND SPECIAL TESTS—55 MEASURING CHECKS

No, the people in our Quality Control Group can't stand even *one* spot before their eyes, when it comes to okaying a bearing, because they are passing on one of the most precise parts that goes into an engine assembly.

In the case of the plain copper-lead main bearing shown above, this okay must be given 87 times.

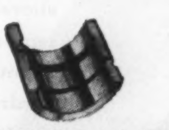
On more complex items—such as flanged bearings—an even greater number of tests is necessary.

These manufacturing controls pay off for you! They are your assurance of high quality and exact adherence to your specifications. You get maximum performance when you use Federal-Mogul *silent* sleeve bearings. Consult our engineers on your requirements.



HIGH SPEED, high temperature, automotive type bearings available in many combinations.

SPEED & LOAD bearings for pumps, compressors, industrial electric motors and similar uses.



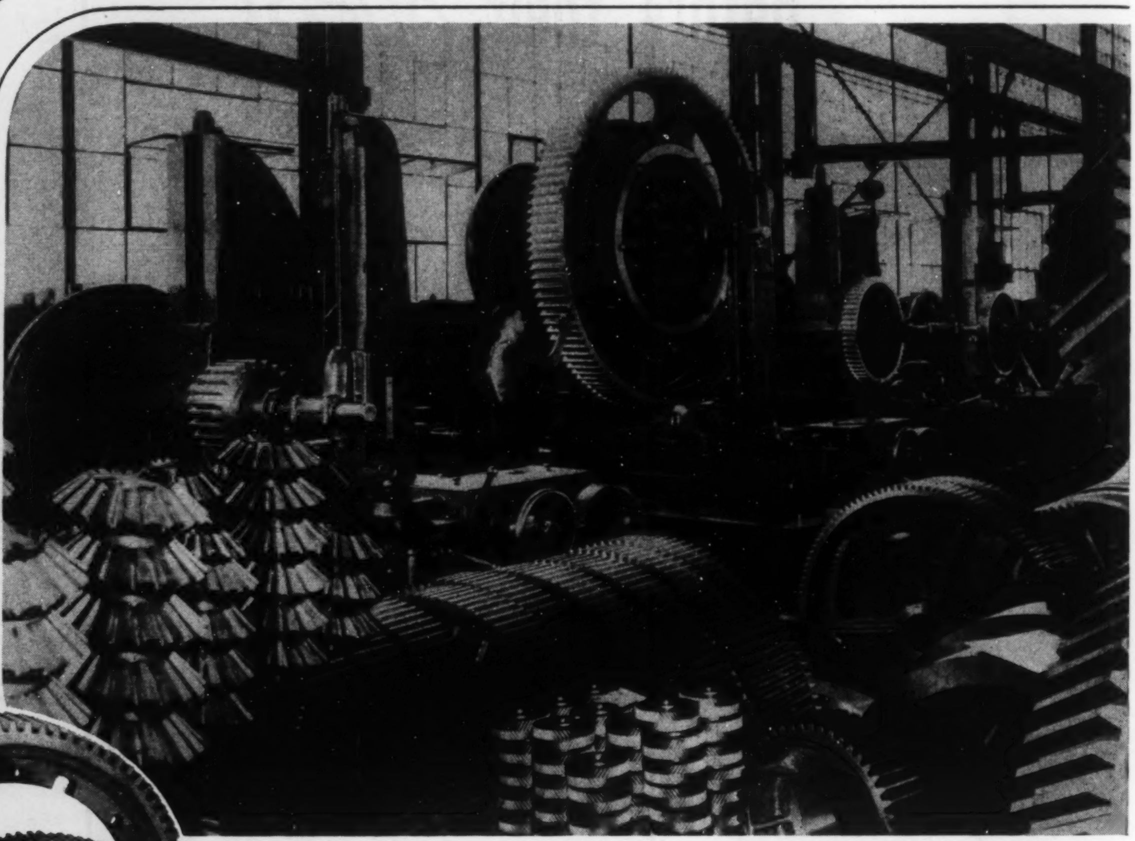
HEAVY LOAD for big Diesels, power plants, etc.—bearings up to 27½" O.D., steel and bronze back.

BRONZE PARTS in many shapes, sizes; thrust washers, bushings; for many types of applications.

1899 • Fifty Years of Continuous Bearing Experience • 1949

FEDERAL-MOGUL

FEDERAL-MOGUL CORPORATION FEDERAL Mogul *Silent* SLEEVE BEARINGS **11045 SHOEMAKER, DETROIT 13, MICH.**



GEARS *of* NELOY *and Neloy Molybdenum for a great diversity of Industrial Machines . . .*

NE

The requirements for diversified heavy industrial Gear Drives in most types of machines are met with Neloy and Neloy Moly Alloy Gear Steels, furnished complete by National Erie Corporation. Drives for billet shears, high speed presses, forging machinery, over-head traveling cranes, power shovels, draglines, to name only a few classes of heavy industrial machines, require NE Alloy Steels, liquid quenched, because the resistance of these steels to impact is at least three times that of ordinary untreated gears. Desired hardness and increased strength result from a combination of alloying and special hardening carefully controlled by National Erie metallurgists. Gear drives cut from Neloy and Neloy Moly Alloy castings meet with outstanding success. Their long resistance to wear and inherent toughness in rough going are of first importance to builders of heavy industrial production equipment. Write for bulletin No. 9 giving full technical details.

NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

NE

This is
UNIONMELT
Welding

Welding heavy-duty grader wheels by UNIONMELT *welding.*

Swing into Mass Production *with UNIONMELT Welding . . .*

It is automatic—fast—easy—Makes top quality welds—Gives maximum production with a minimum of space.

The extremely high currents that can be used with UNIONMELT welding result in deep penetration and high welding speed. The weld metal is clean, uniform, and dense; and requires no chipping or peening to finish it. The UNIONMELT welding is ideally suited to repetitive work. Material from 16 gage to 1½ inches in thickness can be welded in a single pass with this process. By using the proper grade of UNIONMELT composition and welding rod, alloy steels and even non-ferrous alloys can be welded as easily as the regular grades of mild steel.

There are many LINDE methods for joining, forming, cutting, and treating metals. LINDE engineering service is always on call to help customers with production, construction, and maintenance jobs. Just call the nearest LINDE office.

Here are the parts that make up a heavy-duty wheel.

Here are the completed wheels—ready to roll.

Linde
Trade-Mark

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
General Office: New York, N. Y. UCC Offices in Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto
The words "Linde." and "Unionmelt" are registered trade-marks of The Linde Air Products Company

AN UGLY DUCKLING

becomes a thing of grace and beauty!

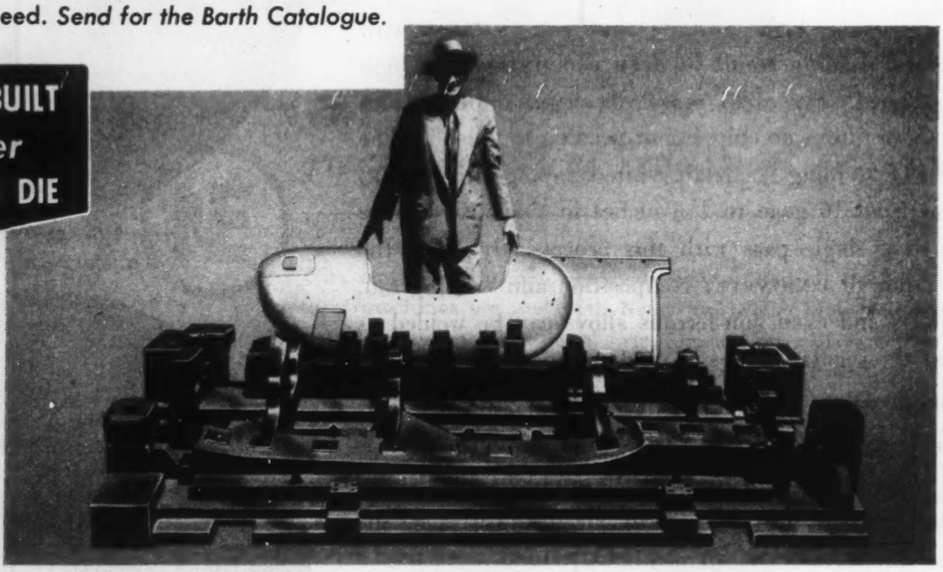
THE LOWLY AUTOMOBILE FENDER has come a long ways in the past few years . . . the once flat and shapeless "mudguard" has become a thing of real grace and beauty, contributing in large measure to the modern, streamline eye-appeal of today's cars in every price bracket.

The Barth Built Fender Piercing Die shown herewith was made for a world renowned body builder . . . a really big die was needed . . . the die and stripper were "kellered" to fit the form of the fender.

The Barth organization has had growing pains too . . . Barth has kept pace with the needs of industry by providing the latest and most modern, up-to-the-minute facilities, experience and equipment for producing tools, dies and special machinery for every industrial need. *Send for the Barth Catalogue.*

BARTH BUILT
fender
PIERCING DIE

Made for a WORLD-RENOWNED BODY BUILDER



BARTH STAMPING & MACHINE WORKS Inc.
Denison at W. 34th St., Cleveland 9, Ohio

DESIGNERS AND BUILDERS OF DIES, TOOLS AND SPECIAL MACHINERY

Alcoa Die Castings Help Make Sales

"what *wonderful* binoculars"

She knows—

They are so light, so strong, priced right. The salesman assured her, the manufacturer guaranteed, the glasses would take abuse. She bought them.

Thousands wanted and bought aluminum binoculars. Now they are the accepted standard. Alcoa Aluminum Die Castings helped loosen purse strings for sales-wise manufacturers . . . gave the optical industry a lift.

There is added appeal for your product as an Alcoa Die Casting. Start planning. Call on Alcoa's 61 years of light-metal experience and 34 years of die-casting know-how for the help you need. Ask for a copy of "Designing for Alcoa Die Castings". Your Alcoa sales office will supply you, or write ALUMINUM COMPANY OF AMERICA, 610 Gulf Building, Pittsburgh 19, Pa.

She doesn't know—

Beyond the ability of the Alcoa organization lie important advantages of Alcoa Die Castings themselves. They won't creep under sustained loads, show little growth even at elevated temperatures. They are excellent conductors of heat and electricity. Add these advantages to a bonus of light weight and a competitive price structure.

ALCOA ALUMINUM Die Castings merit your FIRST consideration

ALCOA ALUMINUM

ALCOA
A C O A ALUMINUM ®

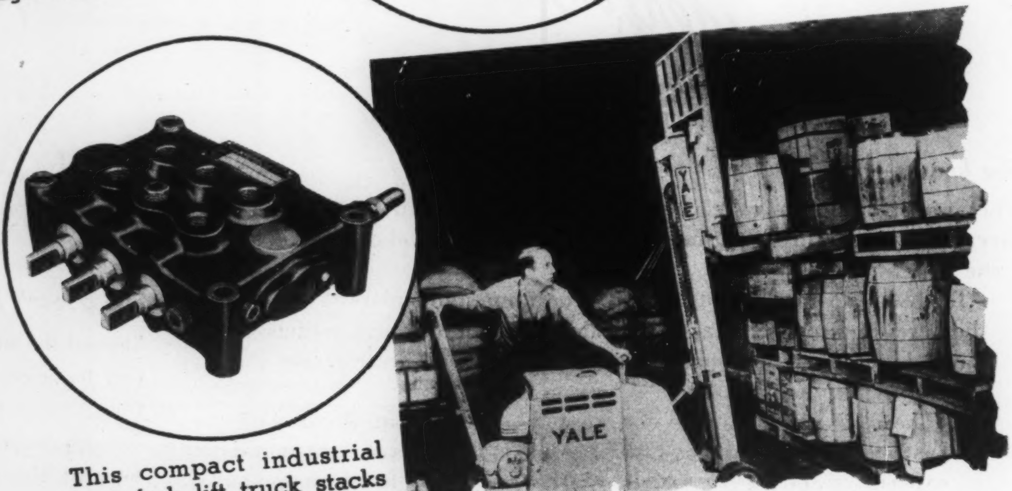
INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

DO YOU USE *Oil Hydraulics?*

. . then there is a HYDRECO Hollow-Plunger* VALVE to fit your equipment

● On this unit a **HYDRECO VALVE** controls the operation of the bottom-dump door and the M-R-S patented weight-transfer cylinder.

This great earth handling unit moves tons of dirt in a single load.



A HYDRECO VALVE controls the amount of lift and angle of mast on this unit.

This compact industrial type fork lift truck stacks pallets loaded with a wide range of products.

Let HYDRECO engineers show you how the performance of your equipment can be improved with HYDRECO pumps, valves and cylinders.

*Hollow-Plunger protected by existing U. S. and Foreign Patents as well as patents applied for.

Write to —

HYDRECO
HYDRAULIC CONTROL DEVICES
PUMPS · CYLINDERS · VALVES

HYDRAULIC EQUIPMENT COMPANY
1106 EAST 222nd STREET • CLEVELAND 17, OHIO

To produce many thousands of cast bronze bearings day after day, to the uniformly high quality synonymous with the name Bunting requires precise foundry control. This control starts with the raw materials necessary for production such as molding and core materials, core binders, fixed carbon fuel, prealloyed metal in ingot form purchased to Bunting's own rigid specifications, and virgin metals used for ladle additions to control metal composition. Then, too, melting and casting procedures are carefully controlled for the following reasons:

❶–To keep gas absorption during melting to a minimum, thus assuring sound, gas-free castings.

❷–To effect complete deoxidation of the metal in the ladle before pouring.

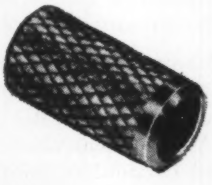
❸–To insure that each particular casting is poured at the precise metal temperature consistent with highest quality.

❹–To insure that molding and core materials are so processed that the correct properties are obtained for good castings, and

❺–To insure metal of uniform composition meeting the specification.

Trained foundry and laboratory personnel are required to carry on this exact control as well as chemical and metallurgical equipment of the latest design. Bunting has always taken pride in being the leading producer of bearing bronze of the highest quality and has the facilities to maintain this leadership. The Bunting Brass & Bronze Company, Toledo 9, Ohio. Branches in principal cities.

86



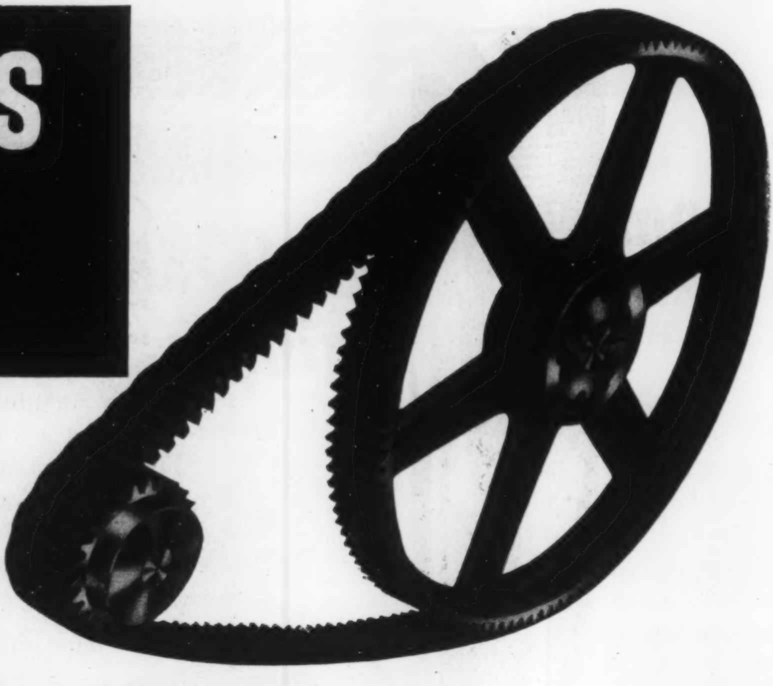
Bunting®

BRONZE BEARINGS

BUSHINGS

PRECISION BRONZE BARS

ENDLESS STORY



Morse Silent Chain Drives

THE STORY of Morse Silent Chain Drives is an endless one of efficiency, low cost and positive power transmission.

Perhaps the most effective known means of transmitting power between shafts, Morse Silent Chain is quiet, smooth, and dependable. Considered by engineers as flexible gearing, it has been used to transmit 5000 h.p. in a single drive; speeds have sometimes exceeded 8000 FPM. At high velocities, Morse Silent Chain Drives utilize centrifugal force to distribute driving effort over a greater number of teeth, reducing impact, wear, and noise.

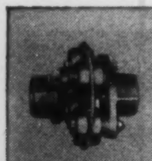
Part of the story of the operating economy and long life of Morse Silent Chain Drives is found in the famous frictionless rocker joint. Employing essentially a simple rocking-chair action, Morse Silent Chain contact is confined to rolling instead of sliding action. Less heat is developed, enabling the drive to transmit heavy loads at high speeds without overheating.

Simple to connect or disconnect, Morse Silent Chains can be installed or removed without dismantling machines on which they are used. Chain length is easily and quickly adjusted for any center distance, and speed ratio changes can be readily accomplished. The initial cost of Morse Silent Chain Drives is surprisingly low, and their high efficiency and frictionless joint design assures the lowest operating cost per hour and low maintenance outlay.

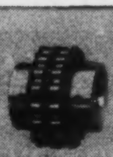
Why not check the Morse Silent Chain story more completely? Write for catalog C71-48. Morse Chain Company, Dept. 372, Detroit 8, Michigan.

* * *

Morse Roller Chain Drives • A low-cost, positive, efficient, flexible drive for use under rigorous operating conditions, Morse Standard Roller Chain is applicable to a wide range of installations and is available in all American Standard pitches and widths.



Morflex Couplings



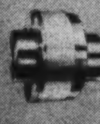
Roller Chain Couplings

Silent Chain Drives

MORSE

MECHANICAL
POWER TRANSMISSION
PRODUCTS

A PRODUCT OF
B-W
BORG-WARNER



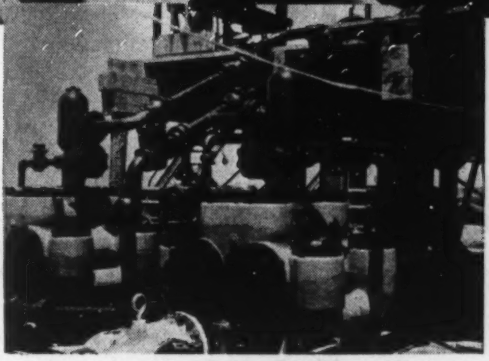
Morflex Radial Couplings

MORSE CHAIN COMPANY • DETROIT 8, MICHIGAN

UNITS BUILT FOR HEAVY PRODUCTION...

USE BARCO JOINTS TO KEEP PRESSURE LINES *FLEXIBLE...*

Barco Flexible Joints provide for expansion and contraction, keep pipes aligned, protect fluid-conveying systems throughout transportation and industry against interruptions or breakdowns. For over 40 years Barco has provided responsive, compensating movement through every angle. Today, there is a Barco Flexible Joint for every need. For more details, write Barco Manufacturing Company, 1806 Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd., Montreal, Canada.



BARCO JOINTS ON A MUD PUMP FOR THE OIL FIELDS

This is one of the many applications using Barco Flexible Joints where a flexible conveyor is required for oil, steam, air, gasoline, tar, water and other fluids. You will find Barco Joints in oil refineries, steel mills, shipyards, working on a wide variety of machines.

BARCO FLEXIBLE JOINTS

Not just a swivel joint ...but a combination of a swivel and ball joint with rotary motion and responsive movement through every angle.

FREE ENTERPRISE—THE CORNERSTONE OF AMERICAN PROSPERITY

"MOVE IN EVERY DIRECTION"

...Look for and Specify

KLIXON PROTECTED MOTORS

KLIXON PROTECTORS

Provide Best Protection Against Motor Burnouts

Avoid costly motor repairs and replacements by specifying and using motors with built-in Klixon Protectors.

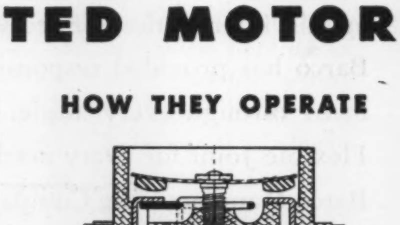
Built-in as an inherent part of the motor by the manufacturer, a Klixon Protector is on duty twenty-four hours a day ready to prevent the motor from burning out should it become dangerously overheated. And because they are built-in you get a proven and tested combination of a motor and protector matched to each other assuring safe protection for the life of the motor.

Regardless of the type of motor driven equipment you manufacture or use, always specify motors with Klixon Protectors. Remember, too, Klixon Protectors are available in transformers, solenoids, variable transformers and other electrical equipment.

SPENCER THERMOSTAT
Division of Metals & Controls Corp.
2506 FOREST STREET, ATTLEBORO, MASS.

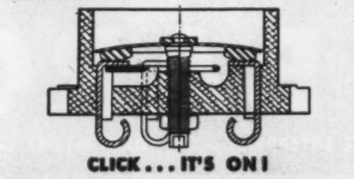
KLIXON

HOW THEY OPERATE



CLICK . . . IT'S OFF!

When temperature within the equipment reaches the danger point, Klixon Protector snaps the power "off" preventing burnouts.

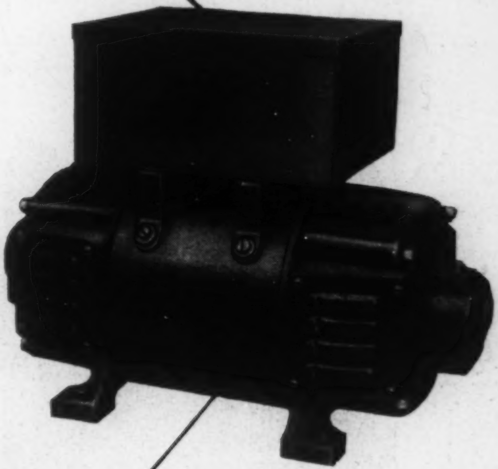


CLICK . . . IT'S ON!

When the equipment cools to safety, the Klixon Protector snaps the power "on" automatically when the automatic reset type is used . . . or by pushing the reset button when manual reset type is used!

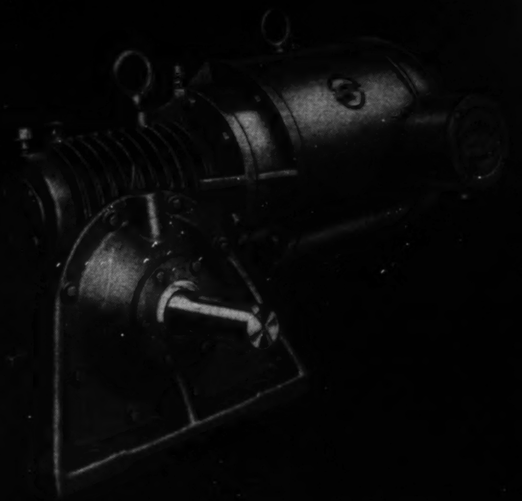
NOW — Your Products Can Step Ahead of Competition With . . .

- Reduced Costs
- Better Product Design
- Stronger Product Sales Appeal
- Greater Plant Operating Efficiency



"the right speed,
the right power"

- GEAR-MOTORS
- MOTORLESS SPEED REDUCERS
- ROTARY CONVERTERS



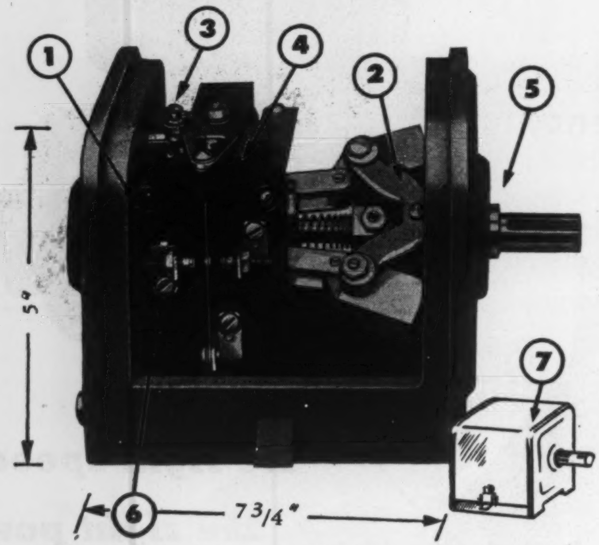
Janette can give you these advantages. Janette Gear-Motors and Motorless Speed Reducers stress the maximum in compactness and efficiency. The result is more freedom for improved product design, with stronger product sales appeal, and more efficient plant operation for the user. Janette's new merchandising plan is designed specifically to help you reduce costs and increase your products sales appeal. For information on how you can obtain these benefits, write today for our Bulletin 5000.

Janette

MANUFACTURING COMPANY
556 West Monroe Street, Chicago 6, Illinois

7 REASONS WHY EUCLID Centrifugal Switches are your answer

. . . for plugging, overspeed or underspeed protection, non-plugging and motion interlocking:



1. Available with any standard contact arrangement. Illustrated above is a two-circuit switch with normally open SPDT contacts.
2. Operating range for contacts to open or close runs from a minimum of 125 rpm to 2530 rpm. Safe maximum speed . . . 3600 rpm.
3. Ball-bearing engaging contact-making arm minimizes friction to assure trouble-free operation.
4. Contact-arm stops prevent undue wear of contacts.
5. Sealed and permanently lubricated precision ball bearings eliminate bearing maintenance.
6. Silver-to-silver contacts assure long life. When necessary, they are easily replaced. Snap-action contacts to assure quick make-and-break are available.
7. Available in dust-tight and oil-resistant enclosures for surface or flange mounting; and also in permissible enclosures for hazardous locations.

Twenty-seven years of control application and manufacturing experience back this Euclid Electric & Manufacturing Centrifugal Switch which is finding wider and wider application on machine tools to increase production; on hazardous industrial machinery to increase safety; and for motion interlocking.

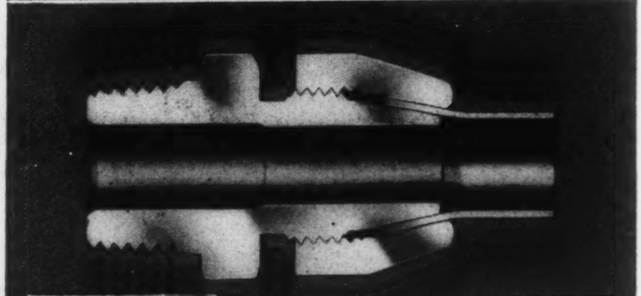
Ask your Euclid Electric & Manufacturing Co. Representative for complete information or write directly to us.

The Euclid Electric & Mfg. Co.
MADISON, OHIO

Vibration under high pressure?

Superseal

Flared Tube Fittings make light wall tubing practical



Jaeger Mfg. Co. compressors have Superseal Fittings.

Would you switch to light wall tubing if you could obtain fittings that withstand vibration under high pressure?

Then you'll be interested in Superseal Flared Tube Fittings which are now standard equipment on steam generators and on air compressors with pressures running up to 600 P.S.I. The same fittings in an Underwriters' Laboratories test maintained a leakproof joint under pressures up to an amazing 8090 pounds, at which pressure the steel tubing split. Grinnell Company, Inc., Providence 1, R. I.

SUPERSEAL FEATURES SAVE TIME, SAVE MONEY!

PERMANENTLY LEAKPROOF JOINTS unaffected by vibration.

FOR ANY TUBING, including welded steel tubing, using a single flare.

LONG, SMOOTH, TAPERED 10° FLARE on fitting and inside of self-aligning nut hold tubing securely.

NO SHEARING ACTION to injure tubing at point of flare when nut is tightened. Tubing actually reinforced.

REPEATED DISCONNECTIONS without injury to tubing.

PRODUCTION FLARING up to 2000 a day on inexpensive flaring machine.

STOCKED IN BRASS AND STEEL, 1/8" to 1/2".

99 YEARS PIPING

GRINNELL

Wichita City Library

Here's a million-dollar question:

189574
Veeder-Root Inc. Hartford, Conn.

How many UNCOUNTED OPPORTUNITIES HAVE YOU...*to increase your product's sales?*

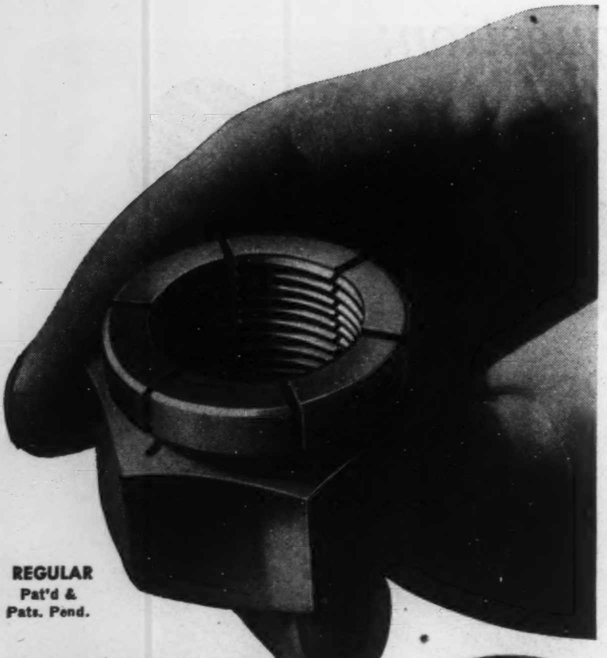
Give a product a useful new feature... give it the ability to supply to its users exact facts-in-figures on its performance or production... and you apply a powerful booster to sales.

This has been proved to manufacturers in almost every industry who have built Veeder-Root Counters into their products as integral parts, to count everything from coins inserted to parts produced. Few counter uses are alike ... *many were not apparent at all* until a Veeder-Root engineer was called in to see if he could figure one out. And today, it's worth anyone's time to find out if he can count his way to new sales (*perhaps even new markets*) with the competitive selling advantages gained by built-in Veeder-Root *Count*rol. How about *your* products? Write.

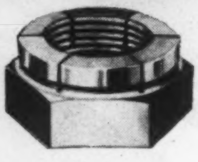
VEEDER-ROOT INCORPORATED, HARTFORD 2, CONNECTICUT

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3. *In Great Britain:* Veeder-Root Ltd., Kilspindie Road, Dundee, Scotland.

Veeder-Root COUNTERS



REGULAR
Pat'd &
Pats. Pend.



THIN

FLEXLOC

ONE-PIECE SELF-LOCKING NUTS

...WON'T SHAKE LOOSE ...REDUCE MAINTENANCE

Invariably, when nuts loosen, they cause shutdowns, loss of production, and bad tempers all around. All this can readily be eliminated by installing the one-piece, self-locking "FLEXLOC", because *it positively will not shake loose* and positively cuts cost of maintenance.

The all-metal, one-piece resilient "FLEXLOC" is becoming increasingly popular, because it is processed to have an exceptionally uniform torque and, because it packs a stop, lock and plain nut all in one. "FLEXLOC" accommodates itself to a wide range of thread tolerances and can be used over and over again without losing much of its torque. And, being a stop nut, it stays locked in any position on a threaded member. It is not affected by temperatures commonly met.

Available in "thin" and "regular" types—in sizes from #6 to 2" in diameter—in NC and NF thread series. Write for your copy of the "FLEXLOC" Catalog.

OVER 46 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNSYLVANIA, BOX 102

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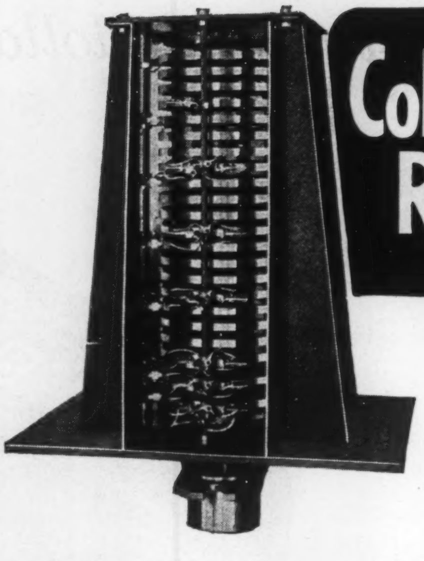


Collector Rings

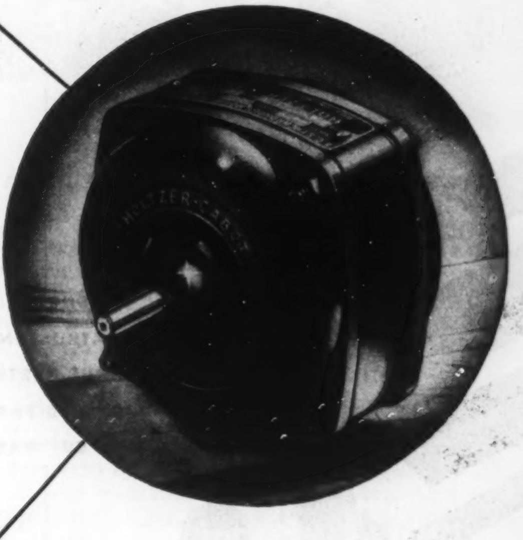
WELCO Collector Rings are made in all sizes to carry currents of 5 to 200 amperes. Two to twelve rings can be furnished on one stub complete with brush holders, brushes, studs for supporting the brush holders and stud rings. The collector rings can be assembled as a unit on one hollow tube with threads on one end and insulation bushings on the opposite end. The brush holders carrying the current are made of brass. The collector rings are made of hard bronze material. Bakelite insulation is used.

Welco Collector Rings are custom-built to fit the special design and functional requirements of your machines or equipment. A limited number of standard types are available. Send us your blueprints and we will design for you the collector rings that are functionally correct.

THE B. A. WESCHE ELECTRIC CO.

1620-20 VINE ST. CINCINNATI 10, OHIO

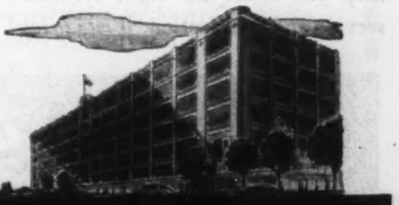
HOLTZER CABOT



FORERUNNER

Ten years ago Holtzer-Cabot instrument motors set a new standard in accuracy and compactness. Today, with ten years of refinement, these dependable products power many of the finest instruments throughout the world. Both synchronous and induction designs are in sizes up to 1/500th horsepower, gear head outputs down to 1 r.p.m. Many models can be secured from stock, or they can be built to special order. Write for complete information.

HOLTZER-CABOT, INC.
AFFILIATED WITH REDMOND COMPANY, INC.
BOSTON 19, MASSACHUSETTS
OFFICES IN NEW YORK, PHILADELPHIA AND CHICAGO



For applications such as Recorders, Industrial Process Controls, Tower Clocks, Timers and Traffic Controls.

DESIGNERS AND MANUFACTURERS OF FRACTIONAL HORSE-POWER ELECTRIC MOTORS FOR THREE-QUARTERS OF A CENTURY

FOR UNLIMITED VARIETIES OF USES

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Synthetic Rubber

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EXTRUSIONS
CUT PARTS
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LATHE CUT WASHERS

As a material for an unlimited variety of uses, Acadia Synthetics are vastly superior in many essential qualities. They are readily compounded to varying degrees of elasticity, plasticity, resilience, etc., to meet specific operating conditions that call for high resistance to light, air, oil, age, wear and other factors.

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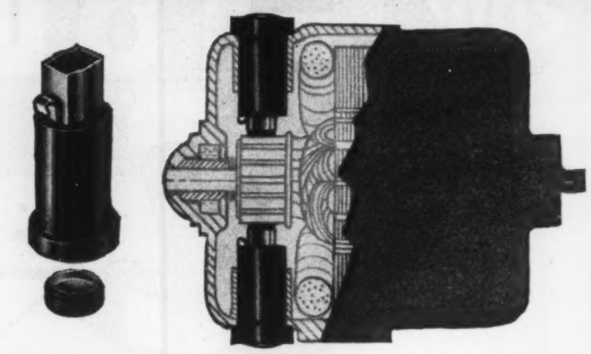
PHOENIX BRUSH HOLDERS
FOR FRACTIONAL HORSEPOWER MOTORS
COMPLETE RANGE OF SIZES . . .



SAVES ASSEMBLY TIME AND LABOR!

Made in a complete range of standard and special sizes for fractional H.P. motors.

PHOENIX Brush-Holders have been used for years by many of the country's leading motor manufacturers. They have proven themselves *in the field* under almost every condition.

Improve your operation, cut your costs, investigate PHOENIX.

PHOENIX ELECTRIC MFG. CO.
711 W. LAKE ST. CHICAGO 6, ILL.

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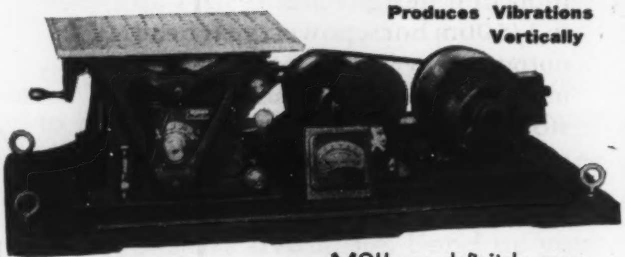
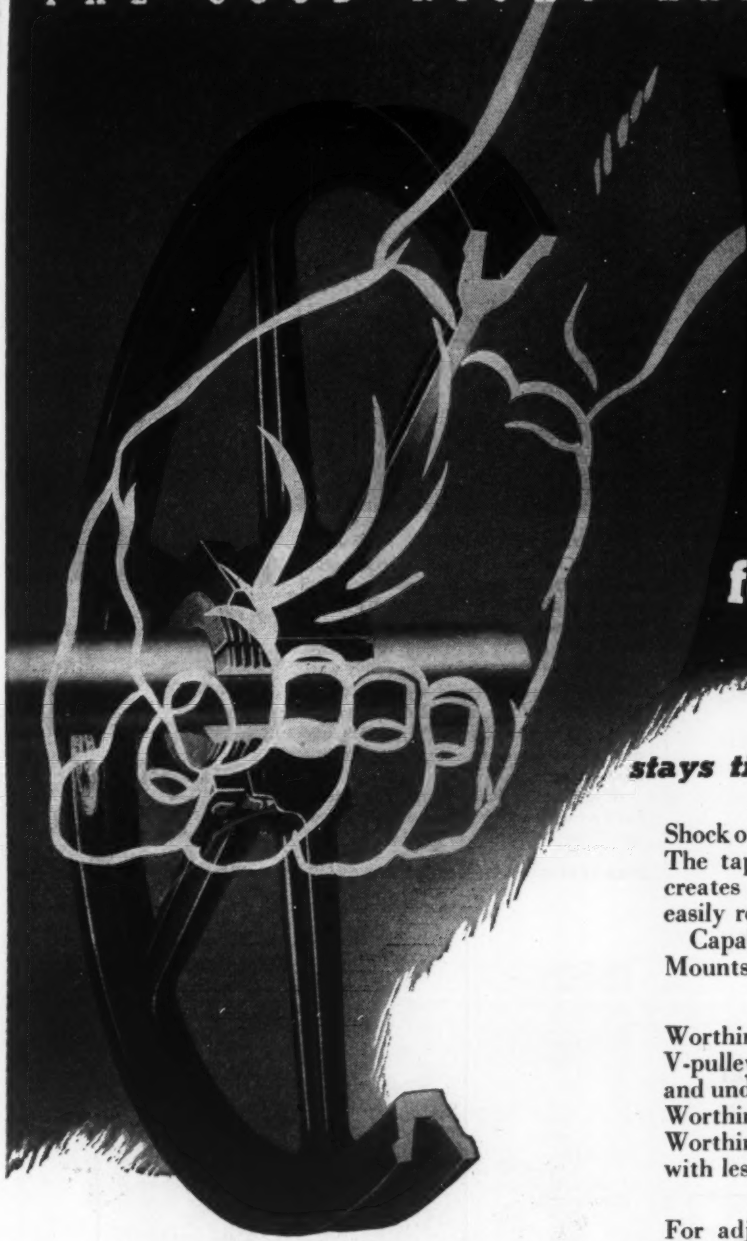
MODEL 100VA
CAPACITY 100 Lbs.
Produces Vibrations Vertically



YOU can definitely acertain how good your product is—substantiate construction and design—eliminate excessive material—through interpreting tests made on the All American Vibration Testing Machine. Eight models for handling parts or assemblies from 10 lbs. to 100 lbs. in weight. Models for vertical and horizontal movement of table. Vibration in simple harmonic motion. Standard machines produce frequencies of 600 to 3,600 v.p.m., manually or automatically controlled. Send for Catalog F. Special machines designed and built to meet your requirements.

ALL AMERICAN
Tool & Manufacturing Co.
1018 W. FULLERTON AVE. CHICAGO 14, ILL.

THE GOOD RIGHT HAND OF INDUSTRY



TAPERED CONE-GRIP

QD JUNIOR

V-PULLEYS for ALL FHP drives

stays tight . . . but permits easy removal

Shock or pulsating loads won't loosen the Junior QD V-pulley. The taper-bored rim, tightened on the tapered split hub, creates a positive press fit on the shaft. Yet the V-pulley is easily removed from the shaft.

Capable of transmitting power without a shaft key. Mounts easily on undersize or oversize shafts.

Bored-to-Shaft-Size FHP V-pulleys

Worthington also offers, for FHP drives, bored-to-shaft-size V-pulleys, precision-machined from solid steel in sizes 3½ in. and under . . . and from cast iron in larger sizes. All arm-type Worthington FHP Cast-Iron V-Pulleys have exclusive Worthington I Beam arm which gives you more strength with less weight.

Adjustable Pitch V-pulleys

For adjustable-pitch drives, use Worthington Adjustable Pitch V-Pulleys, 14 sizes in single and two-groove from 3⅜ in. through 7⅜ in. O. D.

For *every* FHP drive use Worthington-Goodyear FHP V-belts, with the *HEAVY* load-carrying cord located in the *neutral* section for long life and dependable service.

Complete Range of Stock Sizes—Prompt Shipment

98 listed stock sizes in "O", "A" and "B" Sections . . . 193 listed stock sizes of Worthington-Goodyear FHP V-belts. Send coupon for latest Worthington FHP Drive Bulletin, FHP-8.

The original Worthington QD Junior V-Pulley clamps the shaft tighter than any other FHP V-pulley on the market.

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MULTI-V-DRIVE SALES DIVISION
BUFFALO, N. Y.

The Good Right Hand of Industry

POWER TRANSMISSION: sheaves, V-belts, variable speed drives
PUMPS: centrifugal, power, rotary, steam
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Worthington Pump & Machinery Corporation
Multi-V-Drive Sales Division, Dept. MVA.9.3
Buffalo, N. Y.

Send bulletin, FHP-8, on Worthington QD Jr. V-Pulleys.

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Company.....................................

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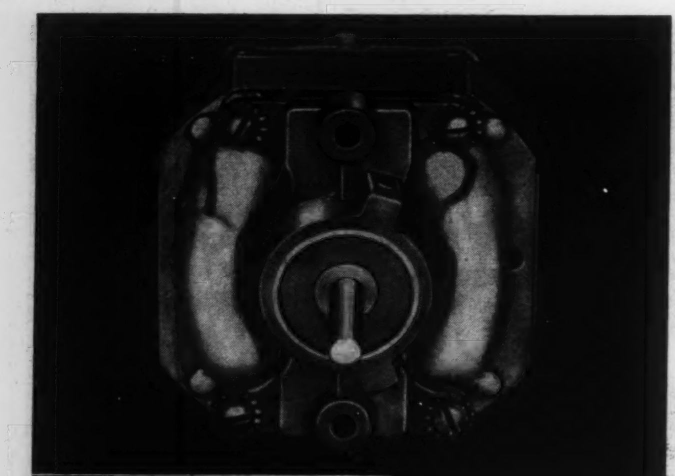
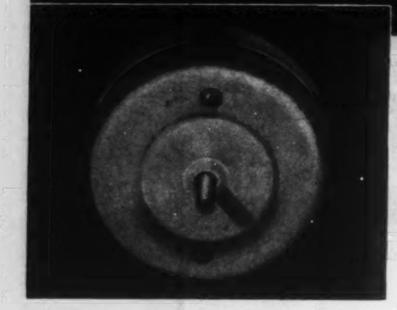


Skeleton view of our improved 4-pole Shaded Pole Motor showing the New 4-Point Bearing Bracket.



Same Motor Enclosed.

A NEW DEVELOPMENT

IN 4-POLE SHADED POLE MOTORS OUR IMPROVED 4-POINT BEARING BRACKET

SKELETON OR ENCLOSED TYPE AS SHOWN
120 v. A.C. — 60 Cy. Approx. 1700 R. P. M.

Our new and improved 4-point bearing bracket makes our 4-pole shaded pole motor outstanding. Compare this motor with *any* other and see for yourself.

- **Absolutely uniform air gap of minimum width.**
- **Permanent rotor position within stator.**
- **Housing entirely separate.**
- **Priced competitively.**

Write, wire or phone for sample telling us your requirements—Memorandum invoice. The Loyd Scruggs Co., 1022-32 N. Sixth St., St. Louis 1, Mo., Telephone: CHestnut 2668.

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and many others.

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MANUFACTURERS OF PRECISION INSTRUMENTS

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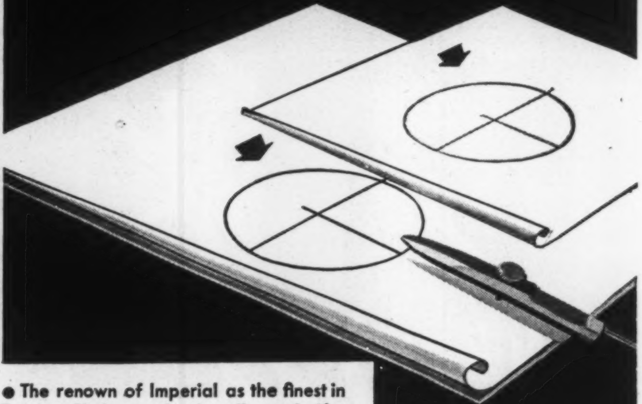

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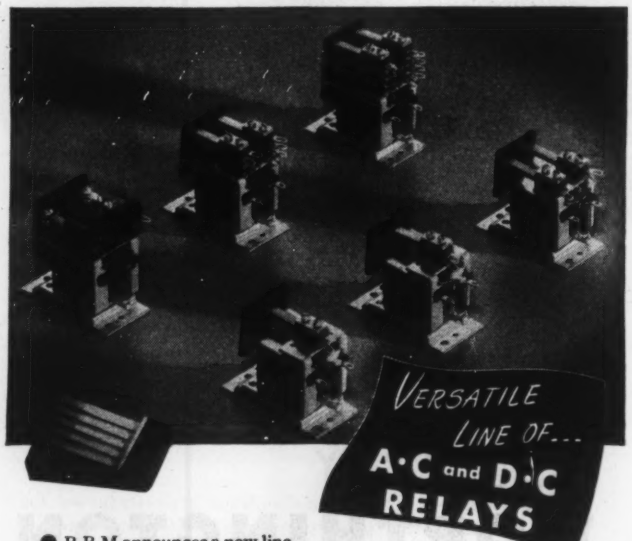
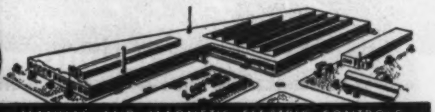


● R-B-M announces a new line of general purpose magnetic relays with either A.C. or D.C. shunt coils or series coils for electronic applications.

Relays are available in standard contact arrangement of single and two pole normally open, normally closed; or double throw with light and heavy contacts. Four and six pole double throw relays are available with 3 ampere contacts at 32 volts or less.

For further information write for Bulletin 570. R-B-M DIVISION, Essex Wire Corporation, Logansport, Ind. Address Dept. H-6.



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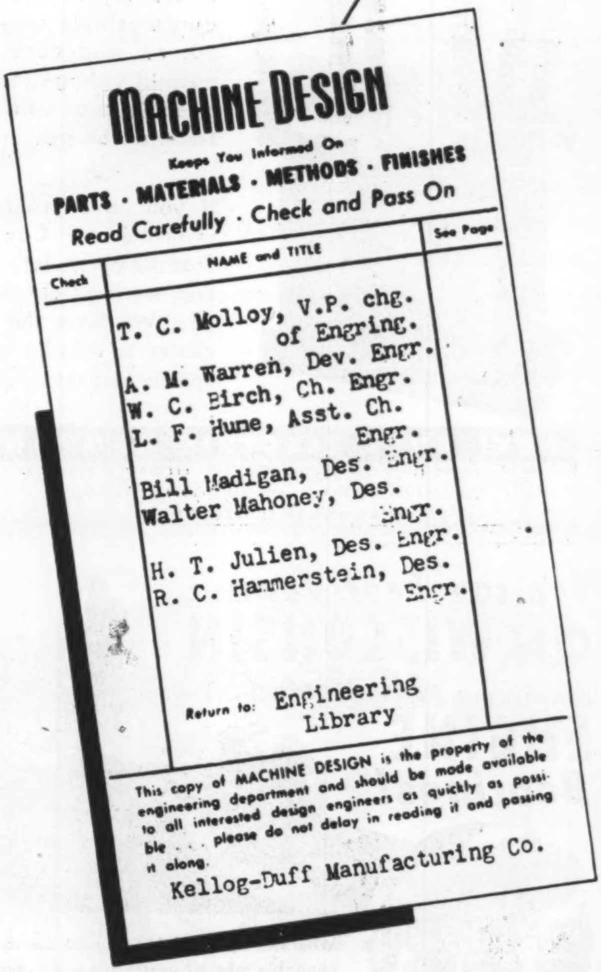

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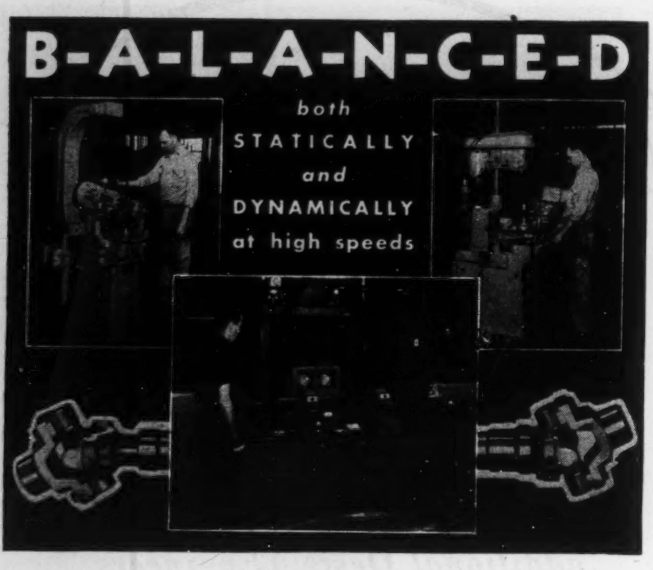

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both
STATICALLY
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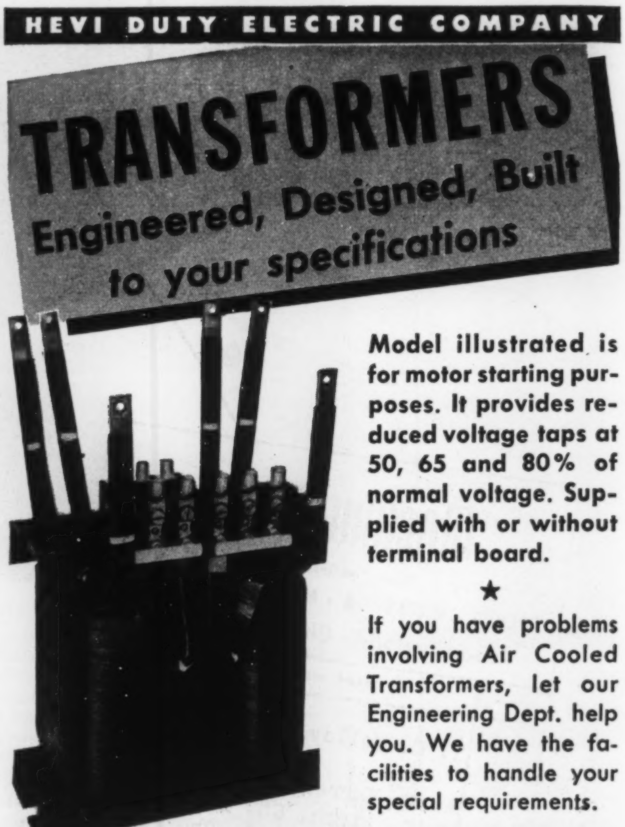
For Cars · Trucks · Busses and Industrial Equipment

HEVI DUTY ELECTRIC COMPANY



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Engineered, Designed, Built to your specifications

Model illustrated is for motor starting purposes. It provides reduced voltage taps at 50, 65 and 80% of normal voltage. Supplied with or without terminal board.

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HEAT TREATING FURNACES HEVI-DUTY ELECTRIC EXCLUSIVELY
DRY TYPE TRANSFORMERS — CONSTANT CURRENT REGULATORS
MILWAUKEE 1, WISCONSIN

You can *bear down . . .* ON WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINE *Bearings!*

Wherever light weight, compact, yet dependable take-off power drives are specified for Wisconsin Heavy-Duty Air-Cooled engine powered equipment . . . V-Belt and Chain drives are popular!

Drive pulley is attached directly to the extended Wisconsin crankshaft on such famous equipment as the V-Belt driven Ingersoll-Rand Compressor above. Outboard bearing is eliminated with no sacrifice in efficiency or increase in engine wear. *Both radial and end thrust loads, or any combination, are taken up by tapered roller bearings built into each end of every Wisconsin crankshaft!*

Couple this adaptability with air-cooling to 140° F., yet fast starts and steady power in sub-zero weather, plus oil pump lubrication that minimizes maintenance . . . and you buy the finest power in the 2 to 30 hp., air-cooled field.

Write for information . . . 4-cycle, singles, two-, and four-cylinder models.

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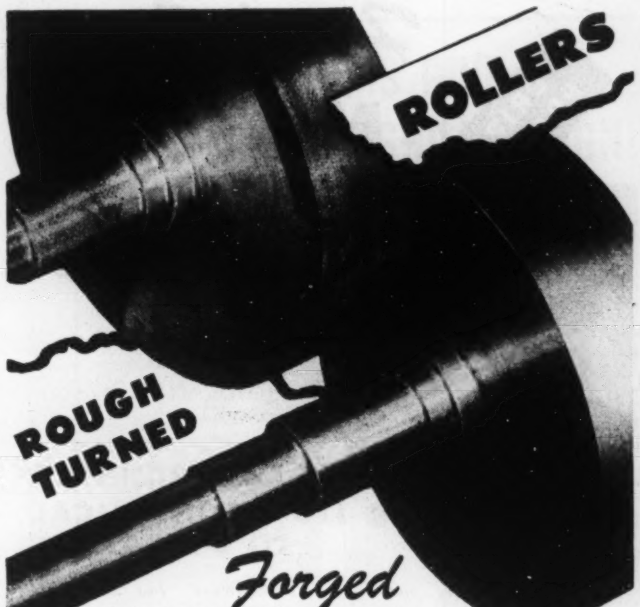
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN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ROUGH TURNED

Forged for uniform texture

One-piece forgings of S. A. E. 6145 steel, forged *right*, then heat treated and rough turned, all at Smith-Armstrong. Here's unvarying, smooth grain for your finish-machining to a whisper, plus density for resisting your high torques and stresses. If you insist on *performance*, insist on Smith-Armstrong forgings.

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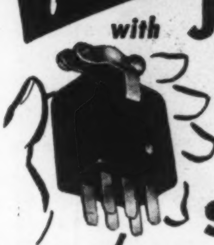
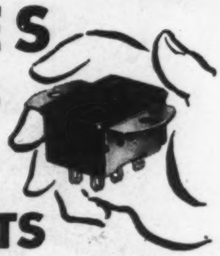
INSURE *Proven Quality* with JONES PLUGS AND SOCKETS



P-306-CCT
Plug, Cable Clamp in Cap.



S-306-AB
Socket with Angle Brackets.

Jones Series 300 Illustrated. Small Plugs & Sockets for 1001 Uses. Cap or panel mounting.

- Knife-switch socket contacts phosphor bronze, cadmium plated.
- Bar type Plug contacts brass, cadmium plated, with cross section of 5/32" by 3/64".
- Insulation molded bakelite.
- All Plugs and Sockets polarized.
- Metal Caps, with formed fibre linings.
- Made in two to 33 contacts.
- For 45 volts, 5 amperes. Efficient at much higher ratings where circuit characteristics permit.

Ask for Jones Catalog No. 17 showing complete line of Electrical Connecting Devices, Plugs, Sockets, Terminal Strips. Write or wire today.

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Cinch Mfg. Corp.
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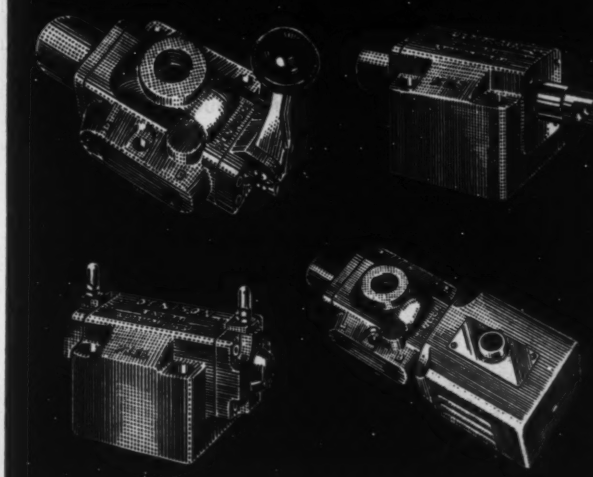
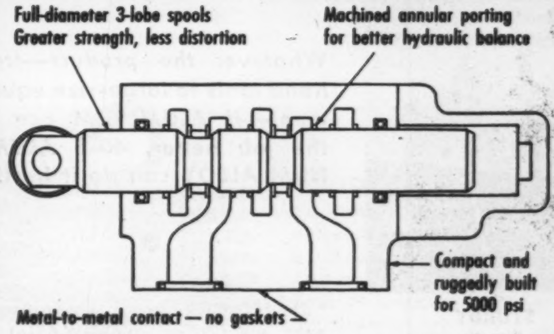
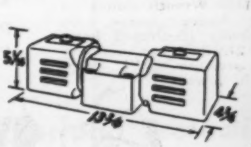
LONGER SERVICE is built into DENISON hydraulic 4-way VALVES

Provided in two types — either threaded or subplate
Complete range of pipe sizes — from ¼" to 1½"




Full-diameter 3-lobe spools
Greater strength, less distortion
Machined annular porting
for better hydraulic balance
Compact and
ruggedly built
for 5000 psi
Metal-to-metal contact — no gaskets

COMPACTNESS:
Check dimensions of the Denison ¾" double-solenoid valve shown at right, with those you are now using.



COMPARE:
Denison Valves with *any* valves on the market today. Compare them for space-saving size; lasting efficiency; modern, rugged construction; low cost. Send for bulletins VD-1 and VD-2 without delay!

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FRONTIER BRONZE CORPORATION NIAGARA FALLS N.Y.

NEW LIGHTWEIGHT PIPE WRENCH

-another triumph for

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40-E ALUMINUM ALLOY!

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Picture clearly shows lightweight feature of new FRONTIER Aluminum Wrench

A sturdy new aluminum pipe wrench that meets highest specifications for usage, yet weighs *less than half* as much as the ordinary-type wrench—that's the newest successful application of Frontier 40-E Aluminum Alloy.*

Produced as a cast wrench by the Frontier Bronze Corporation, the new product has all the wear-resisting qualities inherent in Frontier 40-E —the non-heat-treated aluminum alloy which has given superior performance in so many industrial and commercial uses.

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STURDY
FRONTIER Wrench stands up under heavy usage, as graphically illustrated here, with 215-lb. man exerting full pressure 40" from wrench jaws.

Whatever the product—from hand tools to large-size equipment—if ALUMINUM can do the job better, 40-E ALUMINUM ALLOY can do it best!

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* The FRONTIER Wrench exceeds Government specifications (GGG-W-651a) for pipe wrenches. It is guaranteed against breakage in normal use.

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Write today for Frontier Alloy Data Book which gives pertinent engineering and metallurgical facts about Frontier 40-E Aluminum Alloy.

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SPLASH PROOF
BALL BEARING

- **IT'S COOL RUNNING**
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Selecting a power unit for especially designed machinery or for standard equipment is not a difficult task when you consider that VALLEY MOTORS are built to meet *any* design demand.

Furthermore, you have the added assurance of dependability because of the nationwide acceptance by machinery manufacturers in all industries who have used VALLEY MOTORS for many years.

Why Not Check Into VALLEY Features

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ELECTRIC CORPORATION
4221 FOREST PARK BLVD. • ST. LOUIS 8, MO.

HERE'S THE ALL-PURPOSE SWITCH . . .

SB-1 CONTROL AND TRANSFER SWITCH

You can use this versatile switch on practically any circuit—over 10,000 circuit-sequence combinations are possible. Rated up to 20 amperes at 600 volts a-c or d-c. Compact, sturdy construction. Mount on panels 1/8 to 2 inches thick. Easy to order, too . . . see your G-E sales representative about the SB-1. Write for bulletin GEA-4746. *Apparatus Department, General Electric Company, Schenectady 5, New York.*

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PRECISION ADJUSTMENTS by simply peeling laminations. No grinding, miking, filing. Machining tolerances are greatly increased because the shim provides for exact fit and takeup.

AT-THE-JOB ADJUSTMENTS. No need for standby lathe or operator. The only tool required is a jackknife to peel off a .002" or .003" lamination.

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NO TEA CUP

There is enough bronze being poured here for a hundred centrifugal castings—or maybe not enough for one!

We offer centrifugal castings from 2" length by 3" O. D. all the way up to 328" length by 54" O. D. (world's largest). We make your size.

All our castings—from the pigmies to the giants—have these characteristics in common . . . density, uniformity, and freedom from porosity.

When ordering centrifugal castings, specify "Chief Sandusky".

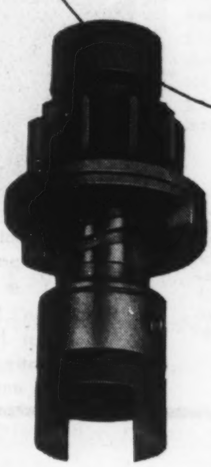
ON THE JOB—Pouring a "Chief Sandusky" Centrifugal Casting.

CHIEF SANDUSKY *CENTRIFUGAL CASTINGS*

SANDUSKY FOUNDRY AND MACHINE CO.
SANDUSKY OHIO, U.S.A.

write Bendix

FOR BETTER, EASIER, MORE ECONOMICAL TRANSFER OF TORQUE



Power Transmittal

Screw Shaft and Pinion—rotation of screw threads moves the pinion backward and forward, allowing the screw shaft to connect and disconnect quickly and easily from a larger gear. Independent coupling on the end for making connections. Available in both right-hand and left-hand types. Useful on reciprocal and oscillating machinery.

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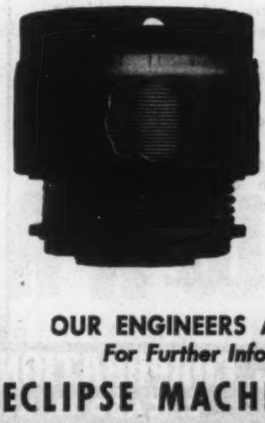
Torsion Spring—available in different sizes, and in both right-hand and left-hand types, up to 100 ft. lbs. A simple and inexpensive safeguard for valuable machinery.



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Multiple Disc Friction Clutch Pack—spring-loaded to slip at a predetermined torque; adjustable from 50 ft. lbs. to 350 ft. lbs. Assures long-life protection wherever torsional loads exist or sudden overloads may damage expensive moving machinery, such as conveyor lines, belts, etc.

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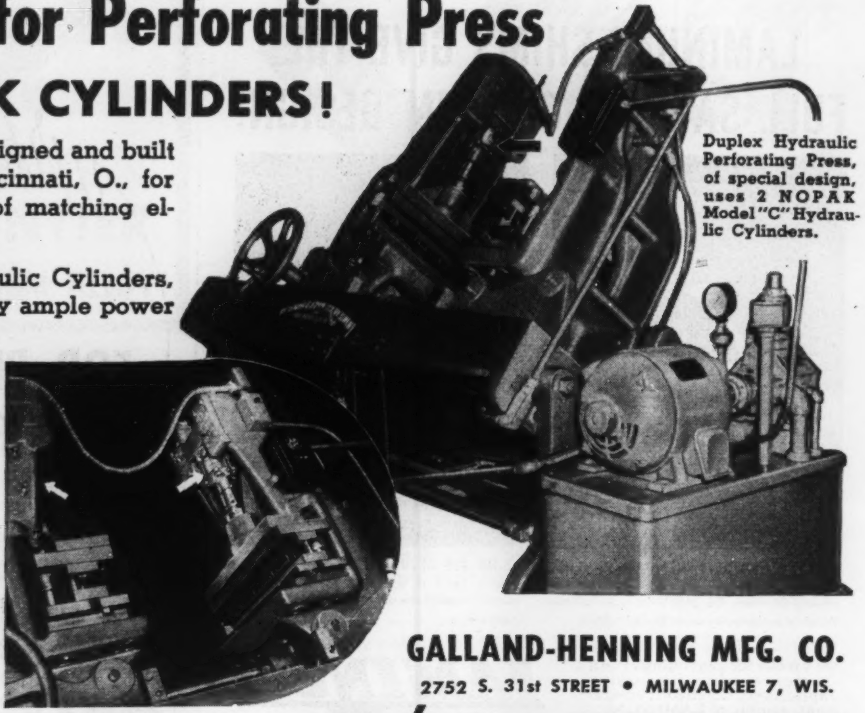
Provided by NOPAK CYLINDERS!

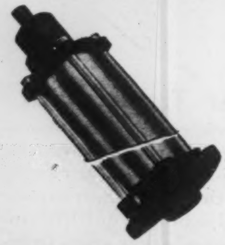
This unique press was specially designed and built by Verdin, Kappes & Verdin, Cincinnati, O., for high-speed, precision perforating of matching elbow blanks.

Two 3" Model "C" NOPAK Hydraulic Cylinders, controlled by one foot valve, supply ample power to perforate sheet steel, up to 24 gauge ● Maximum speed, 100 — 1" strokes per minute ● Maximum capacity, eleven 9/64" holes ● Operating pressure, 400 P.S.I.

This press has reduced spoilage substantially, has resulted in greater accuracy, has increased operating safety by eliminating the flywheel. Chances are that your standard or special machines can be designed for or converted to air or hydraulic operation by employing NOPAK Valves and Cylinders.



Duplex Hydraulic Perforating Press, of special design, uses 2 NOPAK Model "C" Hydraulic Cylinders.



NOPAK Model "C" Cylinder, either Air or Hydraulic, is designed for flat base mounting and vertical pushing power, either up-or-down-stroke.

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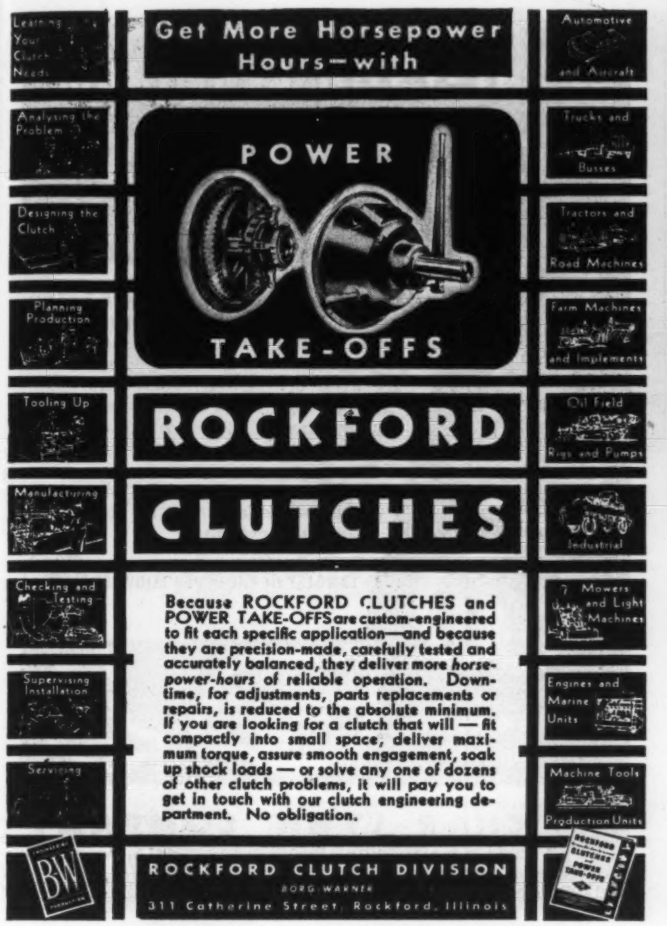

Learning Your Clutch Needs
Analysing the Problem
Designing the Clutch
Planning Production
Tooling Up
Manufacturing
Checking and Testing
Supervising Installation
Servicing
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Trucks and Busses
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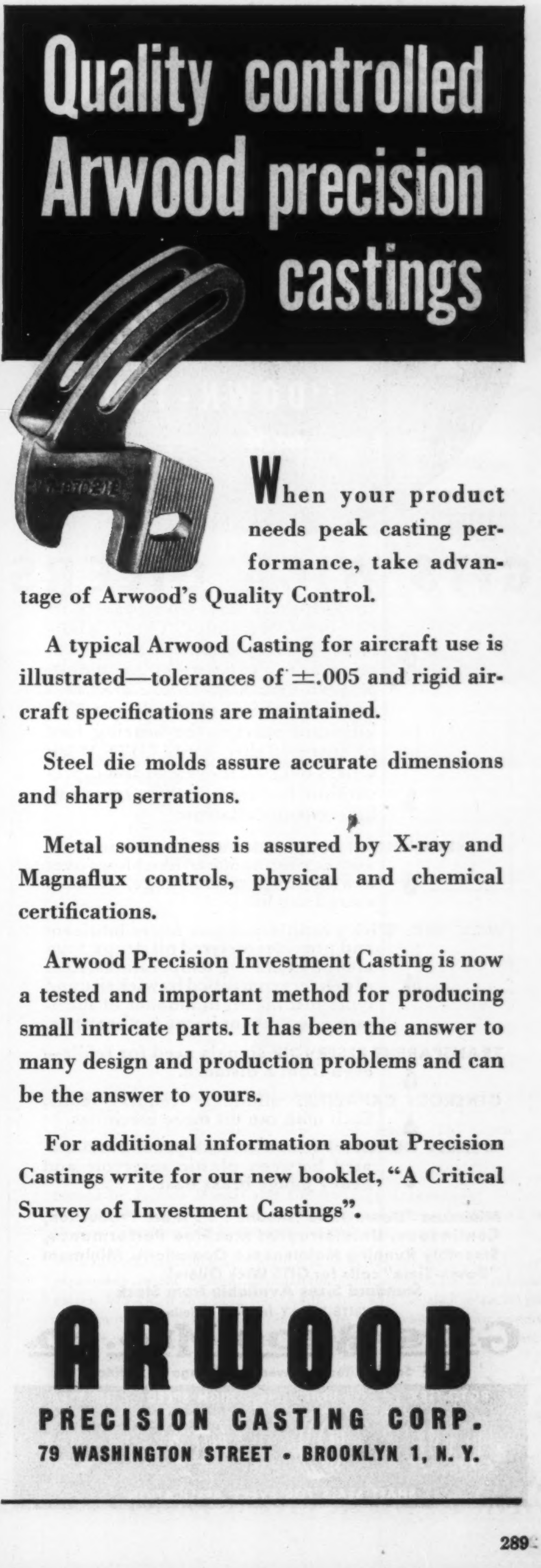

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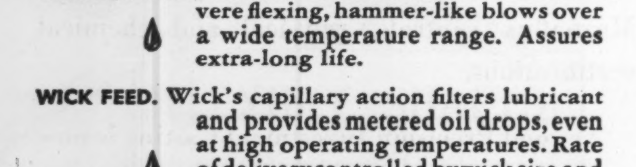

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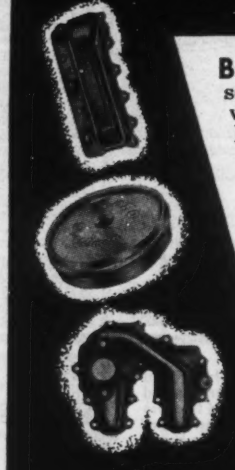

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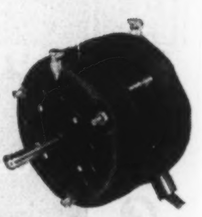

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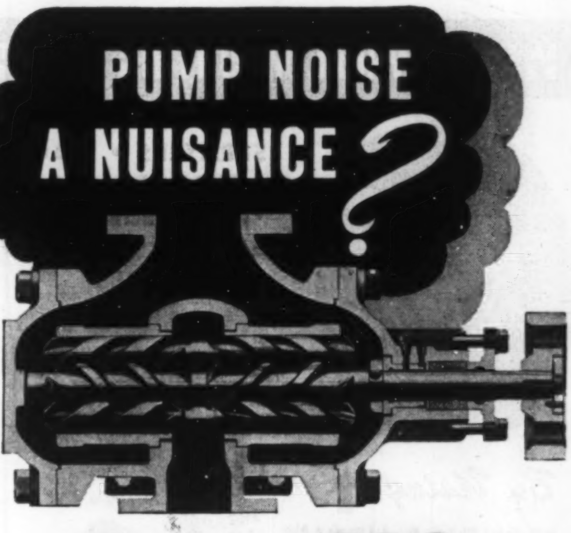

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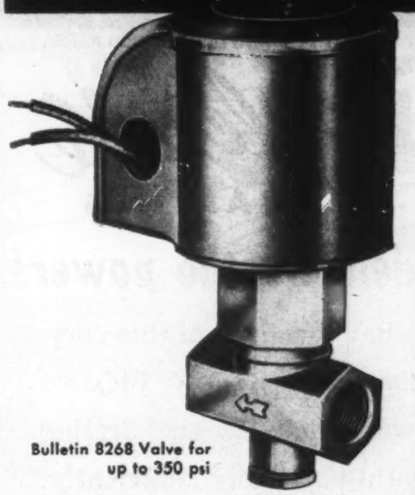

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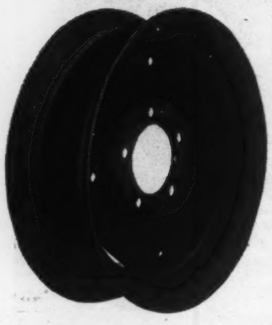

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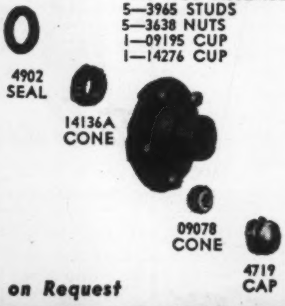

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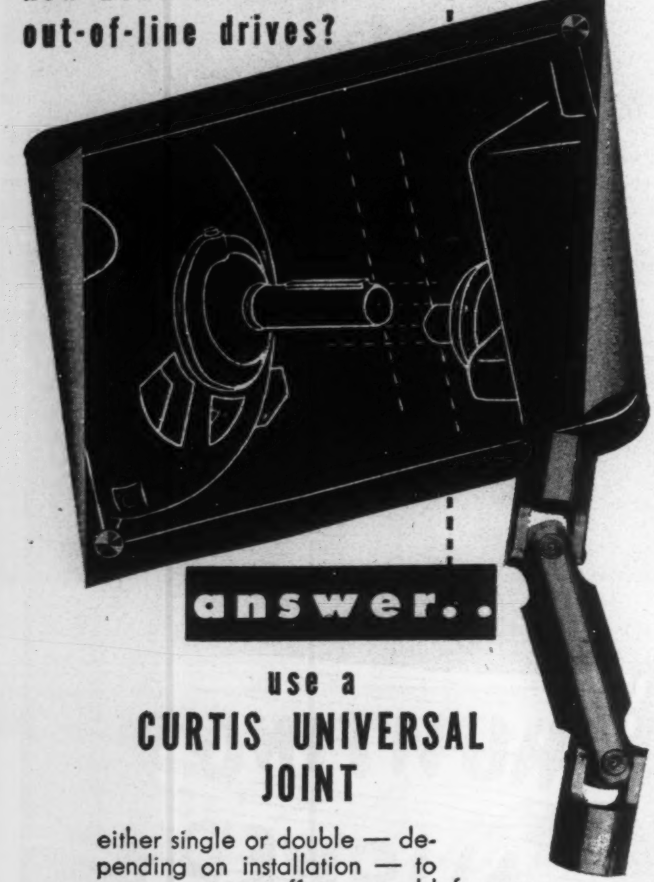

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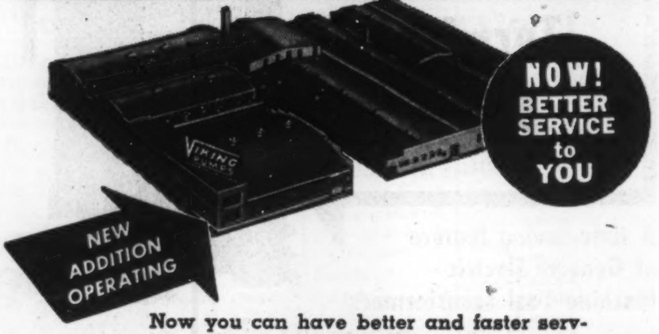

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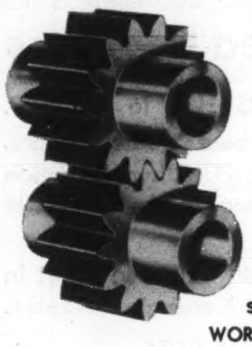

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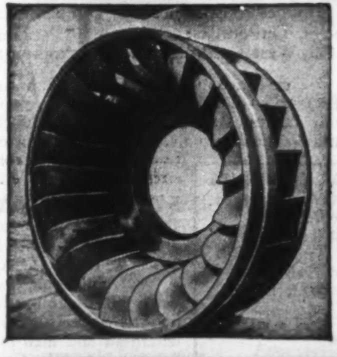

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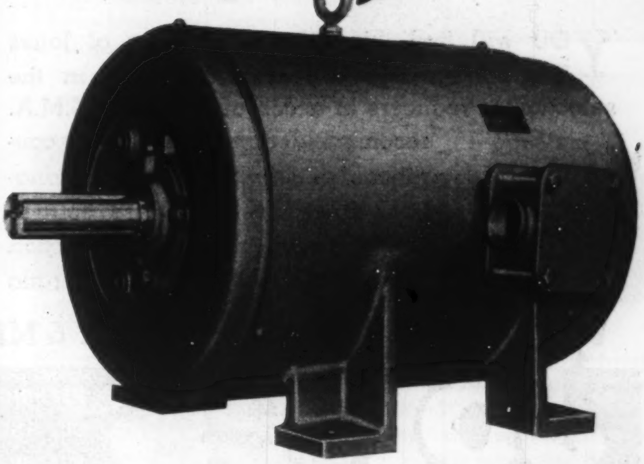

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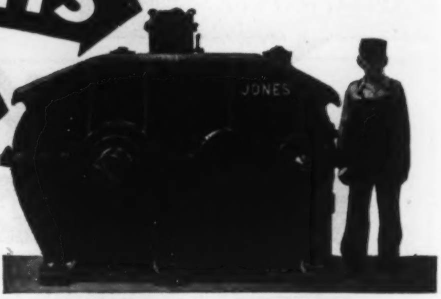

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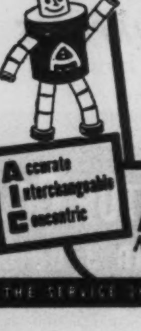

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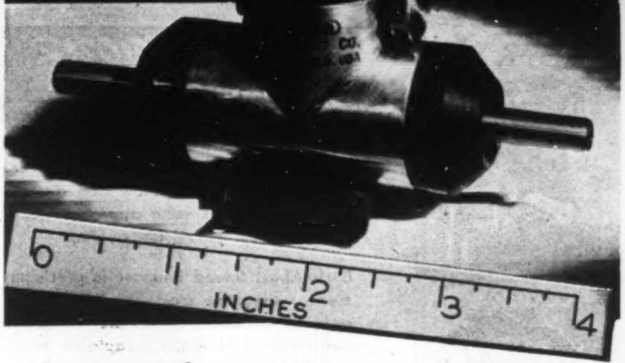

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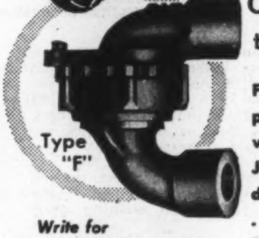

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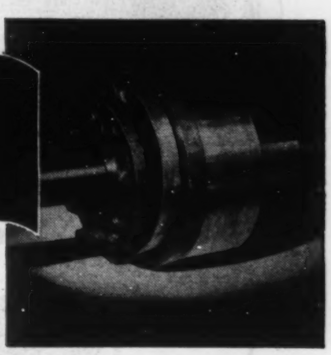

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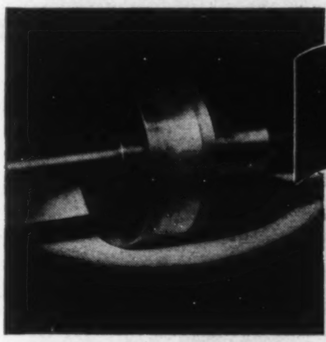

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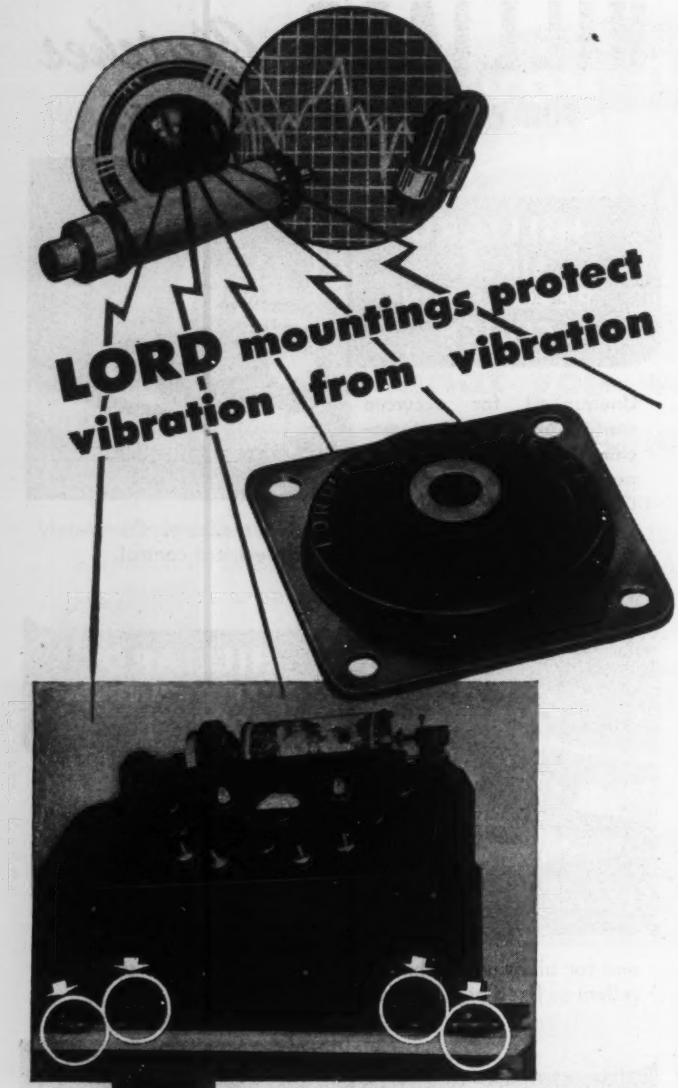
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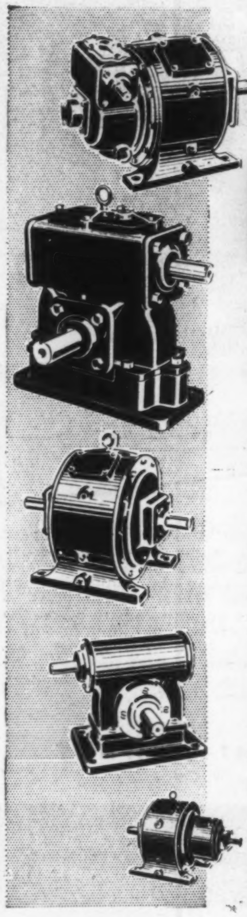

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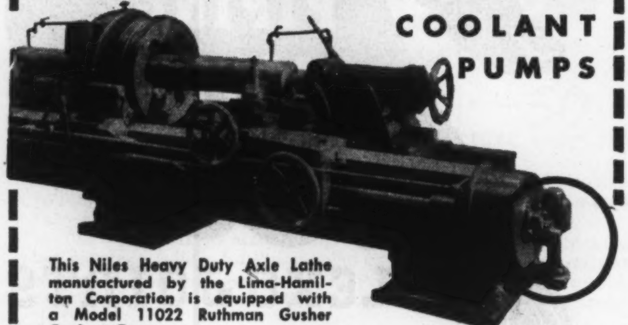

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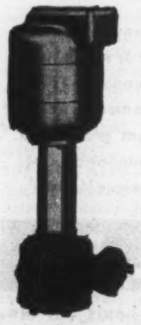

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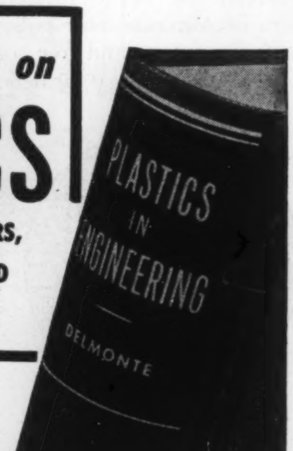

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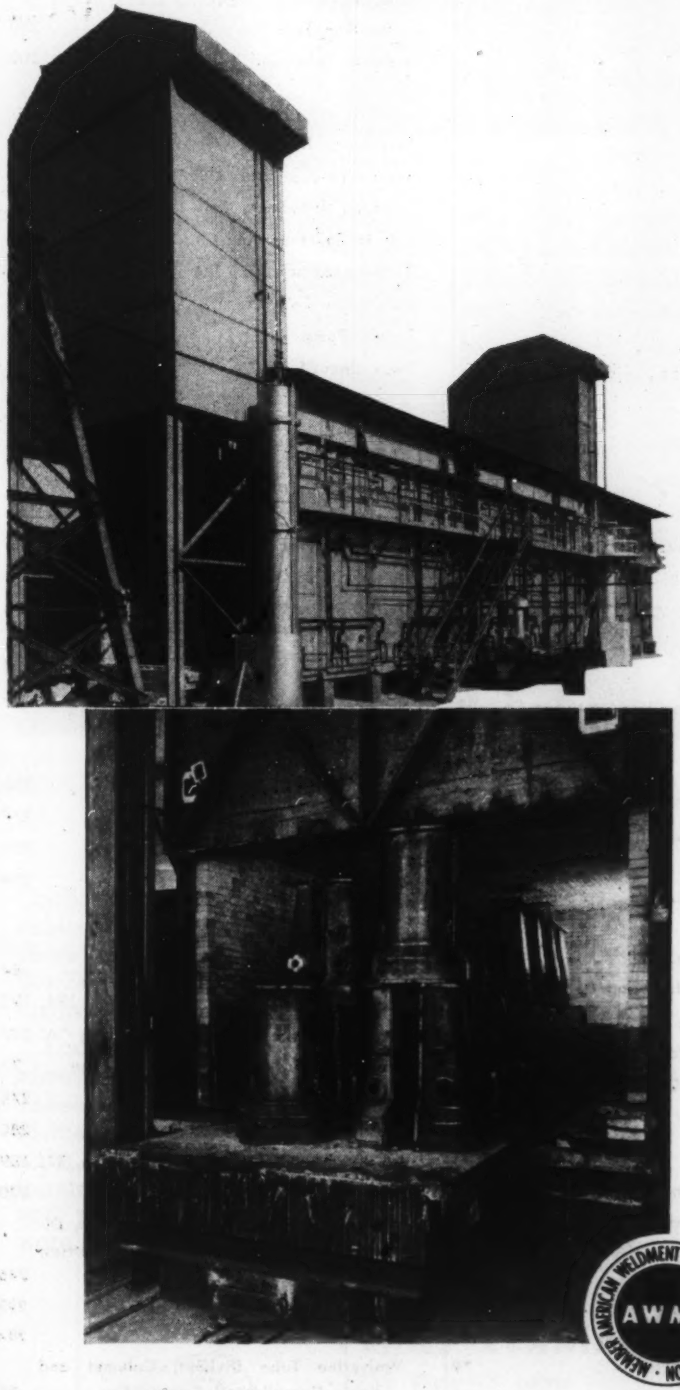

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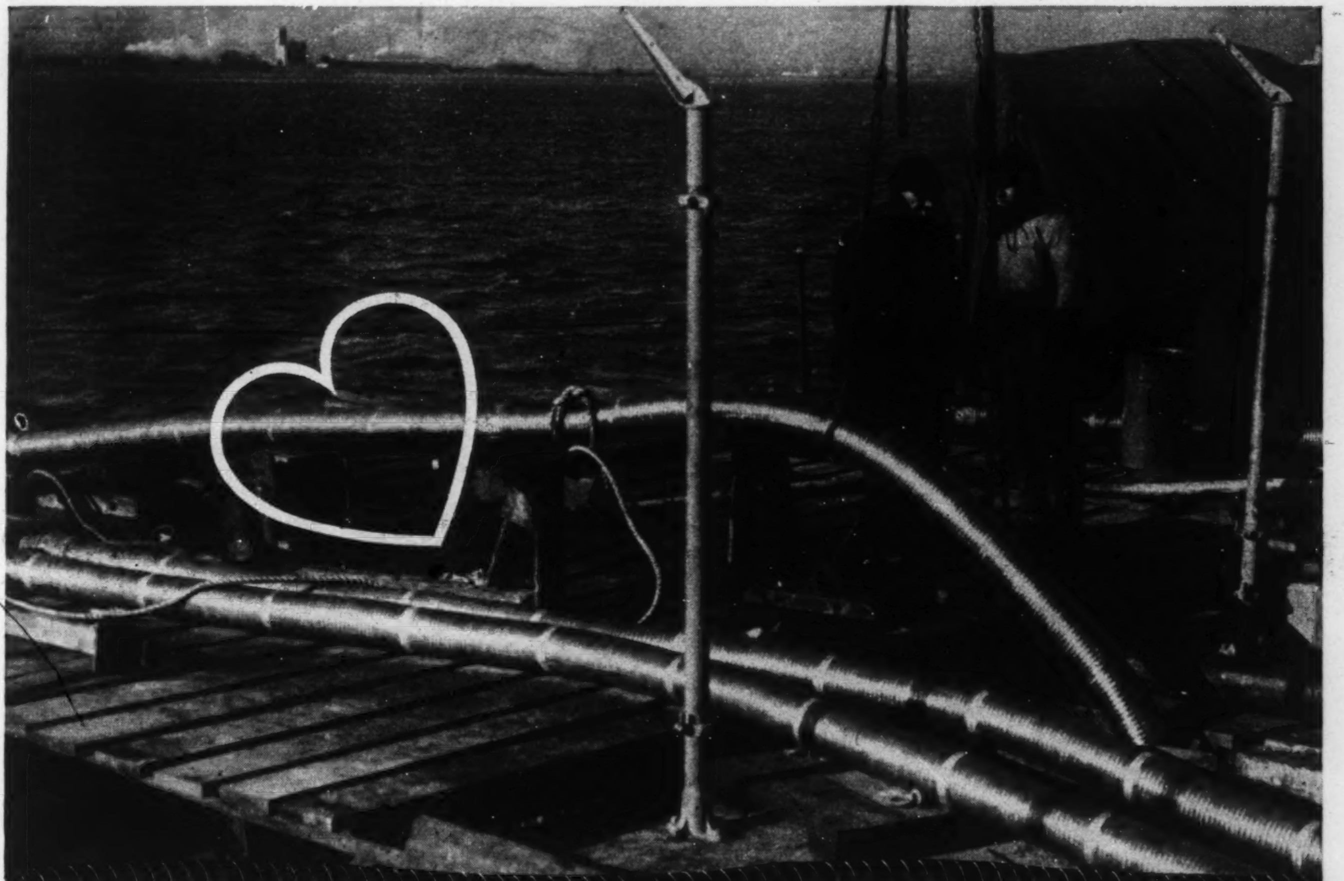

BEATS THE HEAT AT CABLE CROSSING

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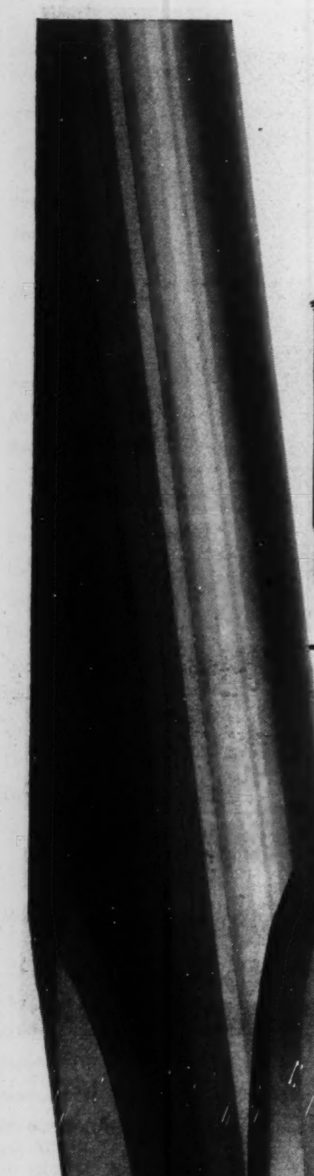
Penflex... HEART OF INDUSTRY'S LIFE LINES


4-WINGED DRIVER CAN'T SLIP OUT
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AMERICAN PHILLIPS SCREWS

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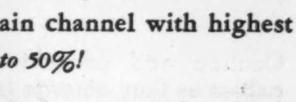

ALL TYPES
ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

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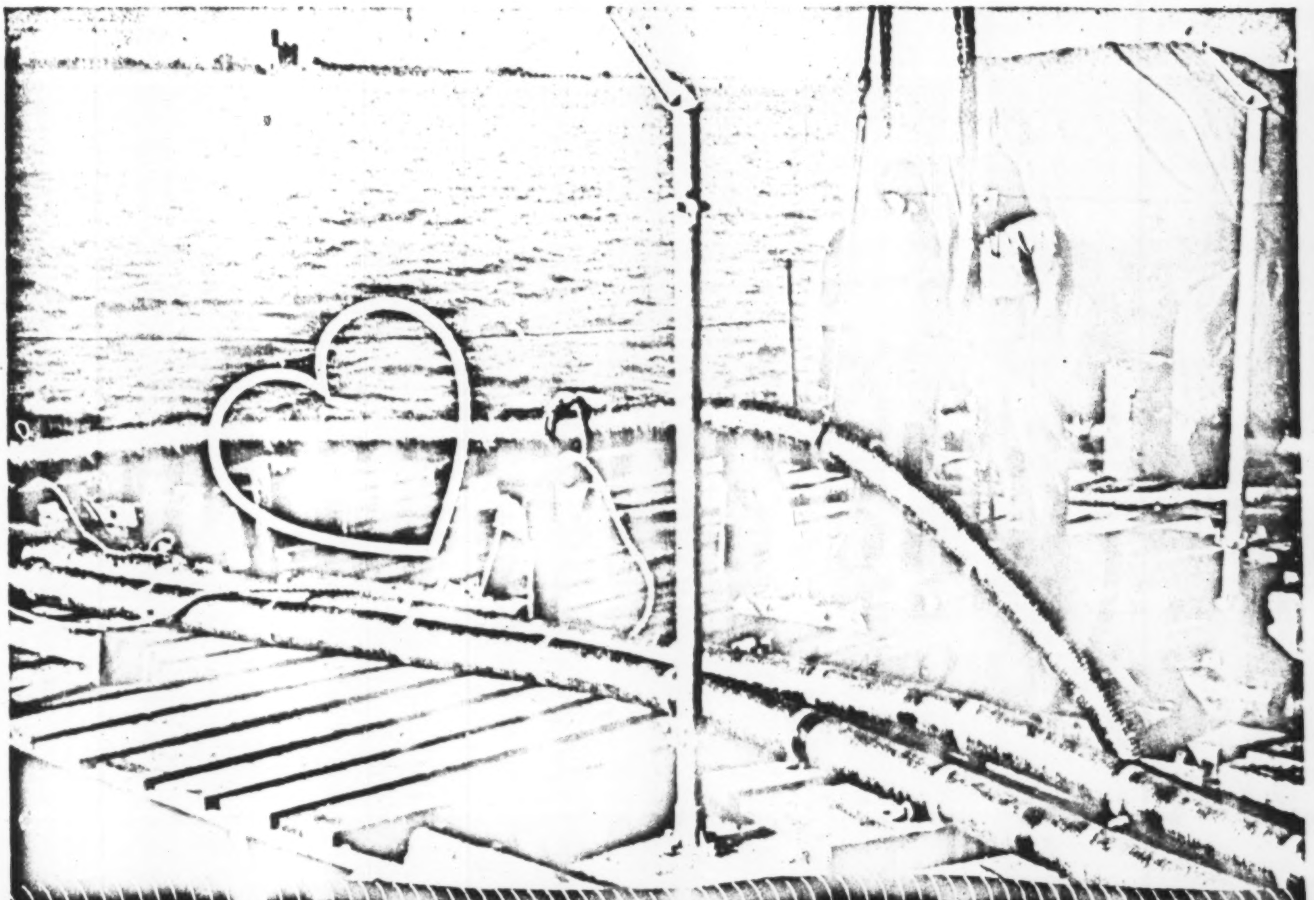

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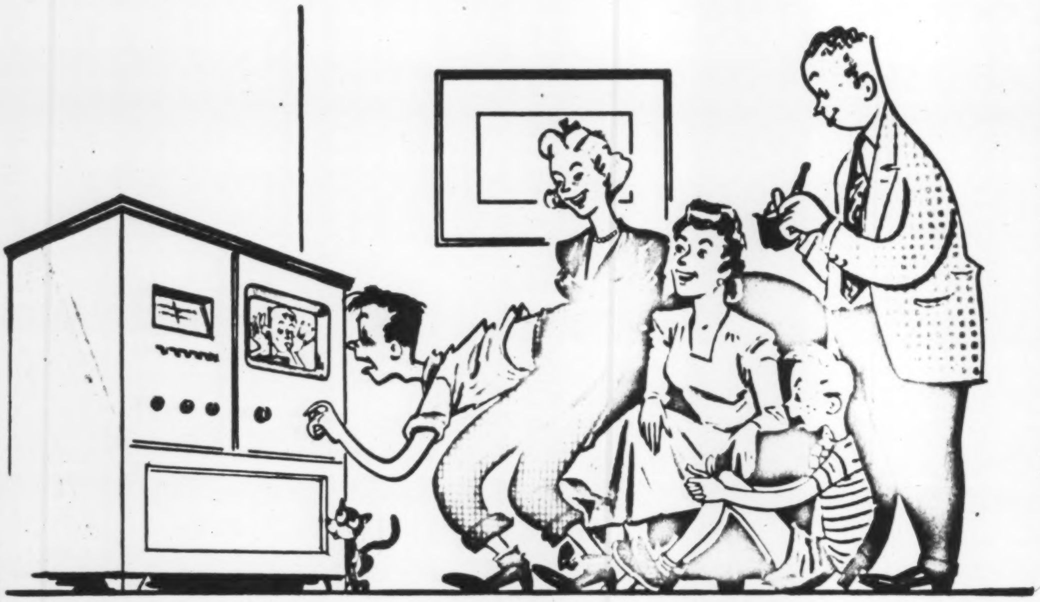

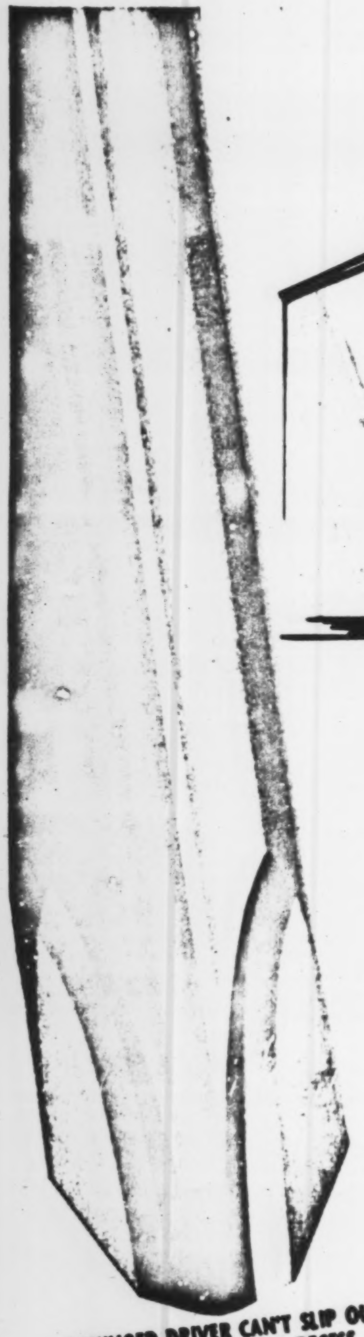

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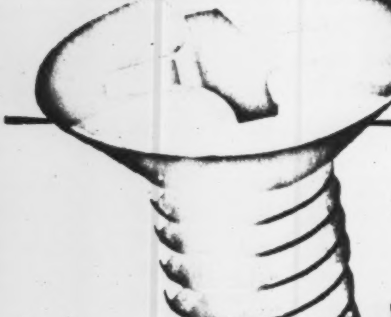

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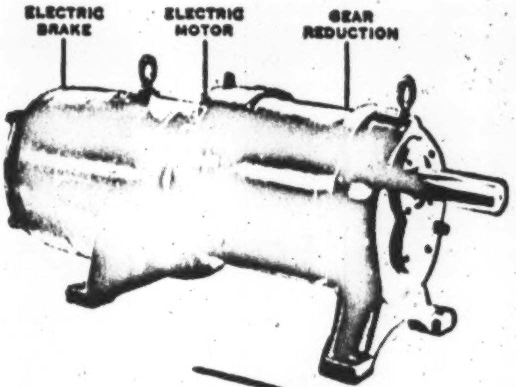
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ELECTRIC MOTOR
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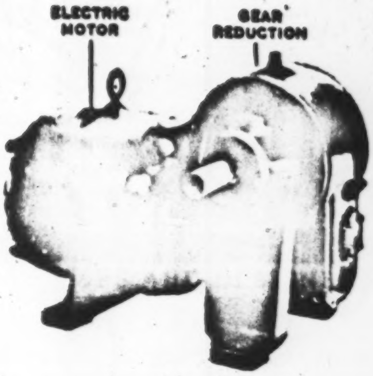
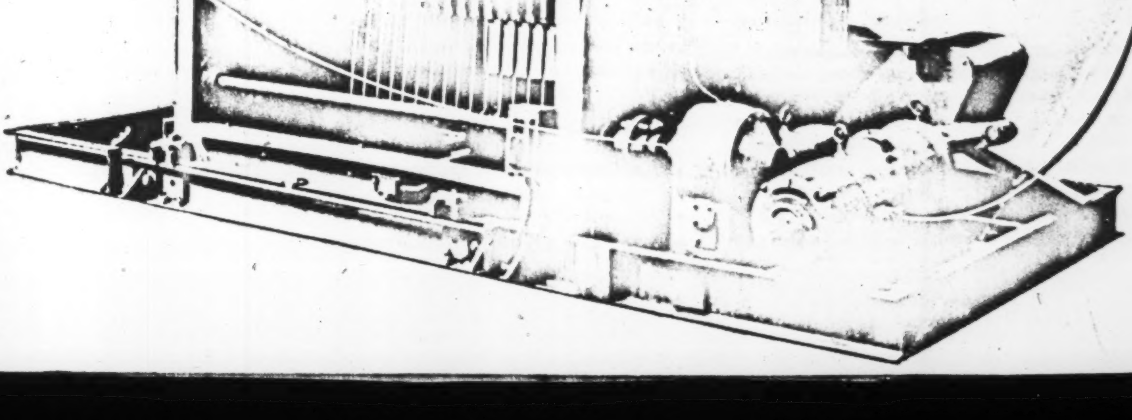

ELECTRIC MOTOR
GEAR REDUCTION

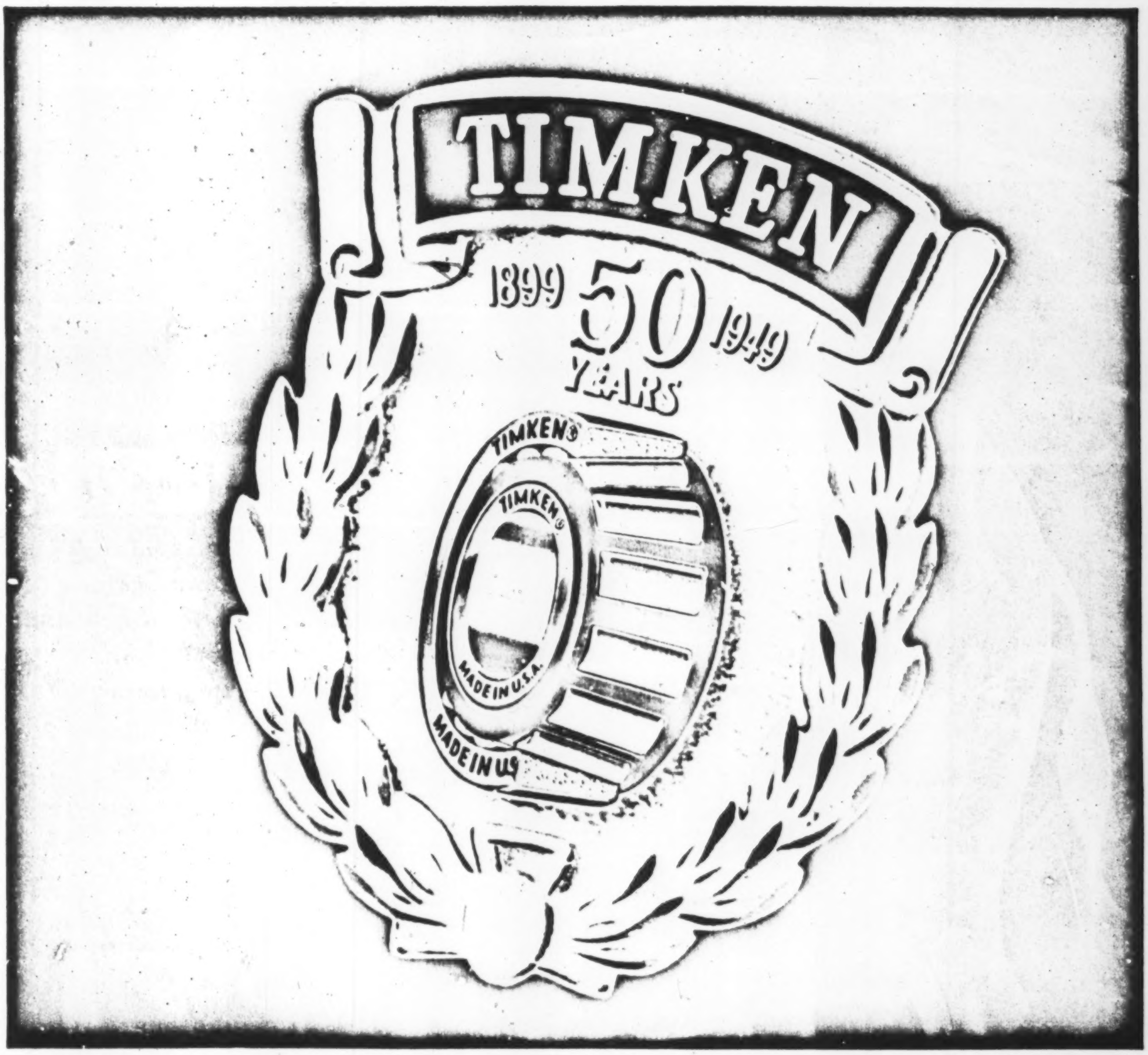
[illegible]

you can always be right

[illegible]

THE [illegible] ELECTRIC COMPANY [illegible] OHIO





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